Volume 63
Number 1

March, 1949
Pages 1-104

$4.00 a Year
$1.25 a Number

Journal of the New England Water Works Association

ISSUED QUARTERLY

Published by
THE NEW ENGLAND WATER WORKS ASSOCIATION
204 Tremont Building, Boston, Massachusetts

Entered as second-class matter September 23, 1903, at the Post Office
at Boston, Mass., under Act of Congress of March 3, 1879
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OF THE
New England Water Works Association
1948 - 1949

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THE Association was organized in Boston, Mass., on June 21, 1882, with the object of providing its members with means of social intercourse and for the exchange of knowledge pertaining to the construction and management of water works. From an original membership of only TWENTY-SEVEN, its growth has prospered until now it includes the names of 900 men. Its membership is divided into six classes, viz.:

A Member shall be an officer or employee of a public or private water works, an engineer, chemist or other person qualified to aid or interested in the advancement of knowledge relative to water works.

An Honorary Member shall be a person of acknowledged eminence in some branch of water supply or of engineering.

A Junior shall be not less than eighteen years nor more than twenty-five years of age, a student or connected with water supply work.

An Associate shall be either a person, firm or corporation engaged in manufacturing or furnishing materials or supplies for the construction or maintenance of water works.

A Corporate Member shall be either a Water Board, Commission, Company or Municipal Corporation.

The initiation fees and annual dues are as follows:

Initiation Fees		*Annual Dues*	
Members	$ 3.00	Members	$ 6.00
Juniors	1.00	Juniors	3.00
Associates	10.00	Associates	20.00
Corporate Members	10.00	Corporate Members	10.00

This Association has at least eight regular meetings each year, of which five are held in Boston, one in northern New England, one in southern New England, and one, the annual convention, held in September on such date as the Executive Committee may designate.

LOCK JOINT REPEAT PERFORMANCES

HARTFORD

9 JOBS SINCE 1918

1940—Top photo: Modern installation of 48" concrete cylinder pipe.

1918—Lower photo: Delivery of 48" pipe by six horse team.

For almost 30 years the increasing demand upon the water supply system of Hartford has been met with Lock Joint pressure pipe lines. Since 1918 nine separate contracts for supplementing the City's existing water supply system have been awarded to Lock Joint Pipe Company. By specifying Lock Joint Reinforced Concrete Pressure Pipe, Hartford, the insurance capital, has assured itself of water supply lines of unfailing service whose estimated life expectancy is better than 100 years!

Repeat orders from Hartford and many other progressive American cities are convincing evidence of the permanent high quality and complete reliability of Lock Joint Reinforced Concrete Pressure Pipe.

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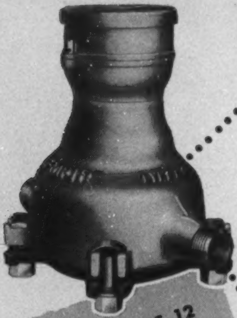
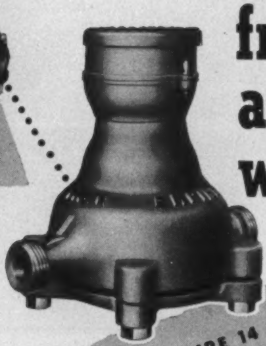
PRESSURE PIPE

How EMPIRE OSCILLATING PISTON METERS cut friction and wear!



EMPIRE TYPE 12
Frost proof model for cold climates. Described in Bulletin W-802.



EMPIRE TYPE 14
Bronze bottom plate model for warm climates. Described in Bulletin W-801.

Empire meters alone enjoy the design advantage of a *balanced* oscillating piston. This piston glides with a circular motion; smoothly, silently between the mirror smooth faces of a snap-joint measuring chamber. Since the piston web is centered to balance water pressure from above and below it . . and because of its featherweight, the Empire piston practically floats. This exclusive construction holds friction and wear to a minimum—results in a super-sensitive meter that measures large and small flows alike with precision accuracy over the longest periods of time.

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Atlanta Boston Chicago Houston Kansas City Los Angeles
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Engineering Facts about

Johns-Manville TRANSITE PRESSURE PIPE

*Winnipeg: A case history**

IN 1932, Winnipeg, Manitoba, installed its first Transite Pressure Pipe. Part of this installation, consisting of an 18″ line, was recently tested in field and laboratory to determine its condition after 14 years of service in an extremely corrosive soil.

Pitometer Flow Test

Assembly of pipe and coupling being removed from the line for laboratory tests.

Before the pipe was removed for laboratory tests, its flow capacity was checked by the Pitometer Company. Velocities ranged from 1.1 to 1.9 feet per second and readings were taken at 30-second intervals. During each test, the velocity was held constant. Results were summarized by the Pitometer Company as follows:

> *"The high value of C-140, which we believe is a reliable index of the present capacity of the pipe tested, shows that there has been little if any loss in capacity since 1932 when the pipe was laid."*

Soil Conditions

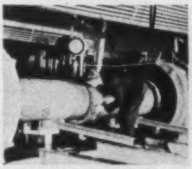
Readings being recorded during Pitometer flow tests on the line.

This Transite Pipe was laid in soil known to be destructive to water pipe. Analysis showed the presence of certain soluble salts, which, when dissolved by ground water, became highly corrosive.

To determine how well the pipe had withstood these corrosive conditions and to estimate its life expectancy, sections of the pipe were removed from the line and subjected to a series of physical tests.

The most significant of these tests were the hydrostatic pressure tests.

Hydrostatic Pressure Tests



The pipe and coupling undergoing pressure test.

To simulate field conditions as closely as possible, an assembly consisting of portions of two lengths of pipe joined by a Simplex Coupling with rubber rings and sleeve intact was tested hydrostatically. Water pressure was raised to 260 psi—the original test pressure to which this pipe was subjected at the factory and 4 times the normal working pressure of the line. The pressure was held at 260 pounds while observers carefully examined the coupling for leakage. No leakage occurred. The rubber rings functioned as well as when the pipe was placed in service 14 years previously. Subsequent inspection and tests confirmed that they were free from any signs of deterioration.

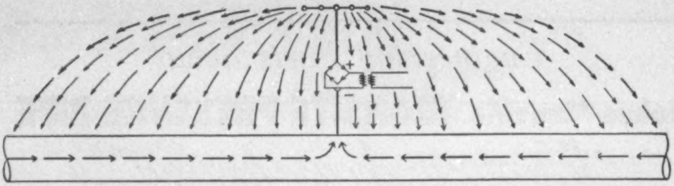
Specimens of the Winnipeg pipe were also subjected to other laboratory tests. Crushing tests showed that the strength of this 14-year pipe compared favorably with that of new Transite Pressure Pipe manufactured today. A corporation stop pull-out test provided further verification that the strength of this pipe was in no way impaired.

Summary

The series of tests outlined above provided conclusive evidence that the strength, flow capacity and other physical characteristics of the Winnipeg pipe were unimpaired after 14 years' service under severe conditions. As the original report states, they demonstrated that "on the basis of the performance rendered to date, it is reasonable to anticipate a life-expectancy of many times that already obtained."

**A copy of the detailed performance report on this Transite Pipe installation is available on request. Address Johns-Manville, Box 290, N.Y. 16, N.Y.*

JOHNS-MANVILLE JM PRODUCTS



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Mechanically applied by modern methods, these coal-tar enamels assure the proper continuity of the insulation.

Electrical inspection improves the quality of application and the handling of pipe during construction and, together with a protective pipe coating of stable dielectric strength, makes cathodic protection economical.

This combination permits the use of a minimum number of cathodic protection units, spaced the maximum distance, and a minimum investment in the complementary electrical protection. A dependable procedure when designing corrosion-proof pipelines.

Barrett

FIELD SERVICE: The Barrett Pipeline Service Department and staff of Field Service men are equipped to provide both technical and on-the-job assistance in the use of Barrett* Enamel.

THE BARRETT DIVISION
ALLIED CHEMICAL & DYE CORPORATION
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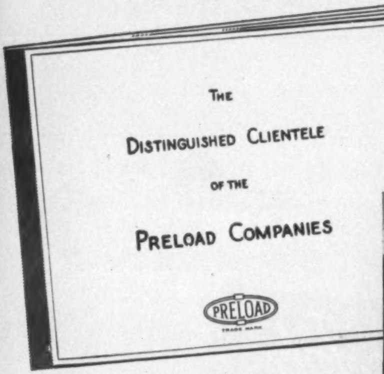

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OF THE

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PRELOAD PRESTRESSED TANKS

This publication, which will be sent upon request, is a useful factual record of the wide range of application of Preload Circular Prestressed Concrete Structures. It is a partial list of some 500 tanks built for 80 clients, including some of the largest industrial organizations and the most progressive municipalities, in widely varying geographic locations and climatic conditions.

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Coating-Jobs

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YOU
YOU

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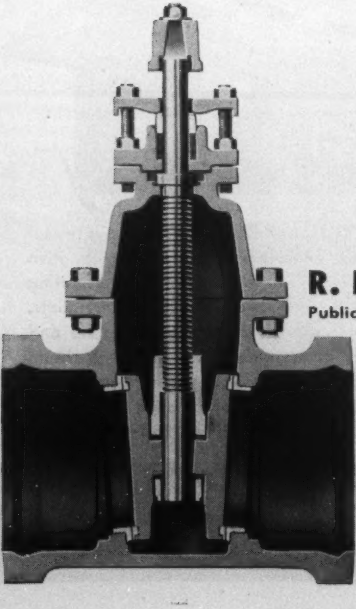

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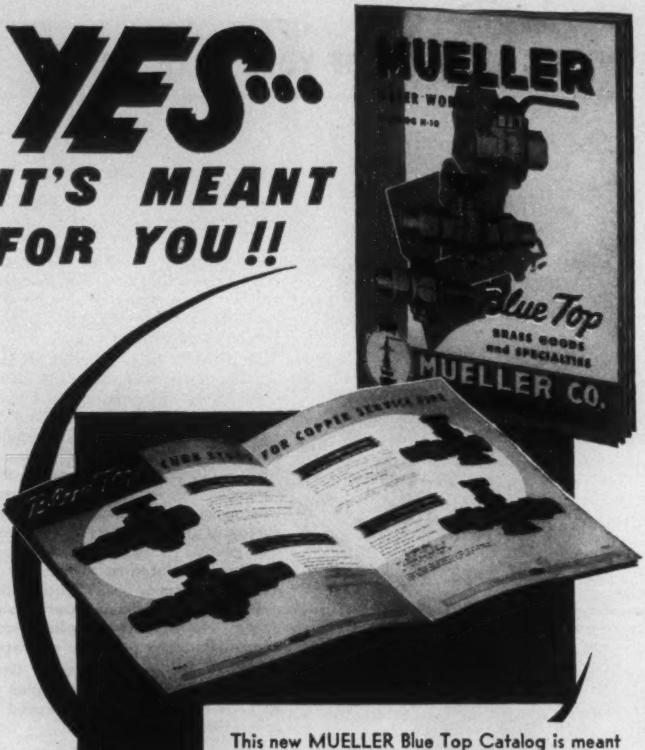
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Blue Top
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REDUCES PUMPING COSTS

▶▶▶▶ WRITE TODAY
FOR THE NEW
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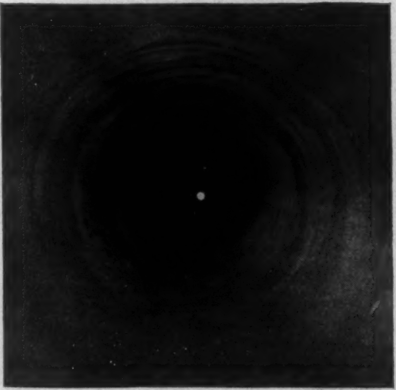
▶ PIPE LINING FACTS NO. 2 ◀



HIGH CARRYING CAPACITY means low pumping costs. Centriline, by assuring perpetually sustained high carrying capacity, keeps the pumping expenditure a low item on the community budget.

Protective cement mortar linings, as applied by Centriline, are continuous, dense, smooth, and without variation in quality. This ever-smooth surface permanently resists corrosion and tuberculation so that pumping expense and depreciation costs go down; coefficient of flow and useful life increases!

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Centrifugally Applied in Strict Conformity
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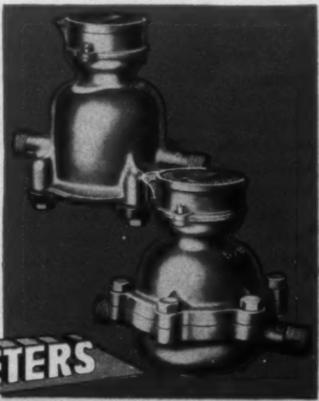
You will find a Badger Meter size and type for every waterworks service. Shown here are Model SC-10T (for warm climates), and Model A-10T (for cold climates) . . . sizes 5/8" to 1¼" . . . other models in sizes up to 12". Write for complete information and prices.



BADGER Water METERS

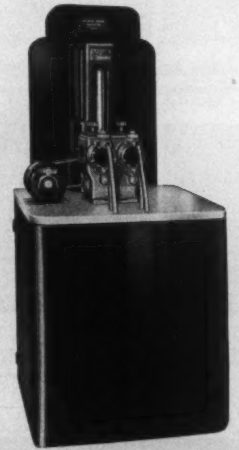
ACCURACY · LOW-COST MAINTENANCE · DURABILITY · SENSITIVENESS

EXTRA # BIG NEWS **EXTRA**

FOR SMALL WATER WORKS

NOW YOU CAN USE MODERN CHLORINE DIOXIDE TREATMENT

Jamestown Water Company, Jamestown, R. I., uses %Proportioneers% Chlorine Dioxide Treatment for taste and odor removal.



With %Proportioneers% Chlorine Dioxide Treating Unit, you can now have the advantages of complete chlorine dioxide water treatment even though your plant handles one million gallons per day or less. It's the modern way to eliminate the tastes and odors due to organic matter and heavy prechlorination. In all types of contaminated water, whether the pH is high or low, sterilization is doubly sure with chlorine dioxide — and effective chlorine residuals are retained over long distances, right to the end of the lines.

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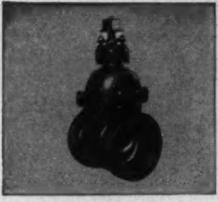
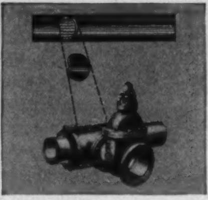
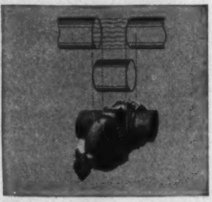


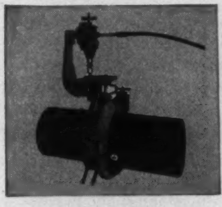
Gate Valves, for low, medium or high pressure service. Manual, hydraulic cylinder, or motor operation.



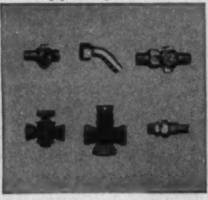
Tapping Sleeves and Valves, for making branch connections (sizes 2″ thru 42″) under pressure to cast iron, steel, asbestos-cement or reinforced concrete pipe of any size.



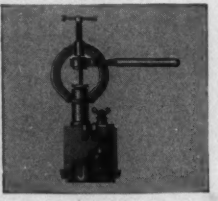
Inserting Valves, for installation under pressure in cast iron, steel or asbestos-cement pipe. Sizes 4″ thru 48″.



Pipe Cutting Machines. With the SMITH machine a true "lathe" cut can be made in cast iron, steel or asbestos-cement pipe in a minimum time.



Water Service Brass Goods: corporation—curb cocks, couplings and other fittings for copper tube, lead and iron pipe services.



Corporation Tapping Machines. With the SMITH Tapping Machines corporation cocks can be installed under pressure. The machine is compact and easy to operate.

*** Water works material of proven quality**

FIRE HYDRANTS
GATE VALVES
CHECK VALVES
INSERTING VALVES
TAPPING SLEEVES AND VALVES
[illegible] SERVICE BRASS [illegible]

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FLOOR STANDS
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TAPPING MACHINES
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PIPE CUTTING MACHINES
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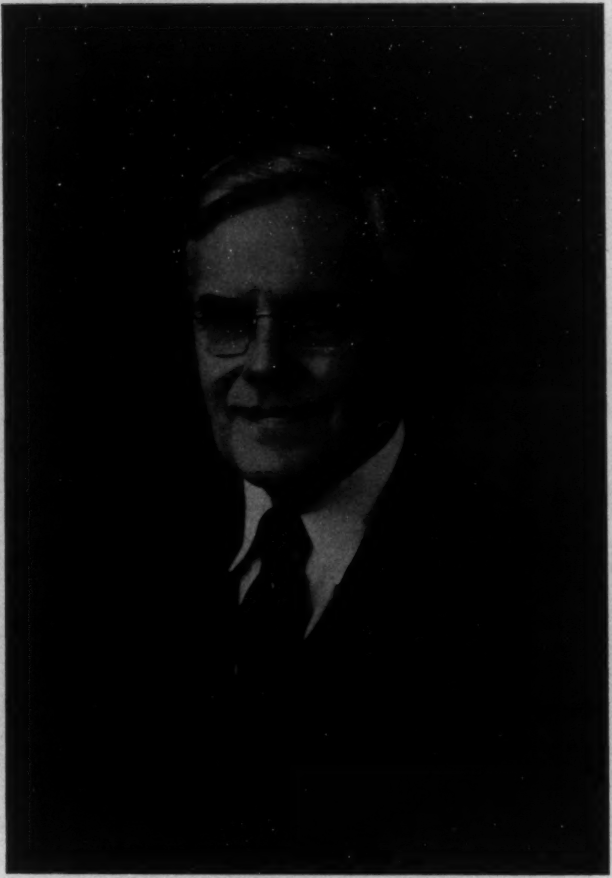


ARTHUR C. KING
PRESIDENT OF THE NEW ENGLAND WATER WORKS ASSOCIATION,
1948-49.

New England Water Works Association
ORGANIZED 1882

VOL. LXIII MARCH, 1949 No. 1

This Association, as a body, is not responsible for the statements or opinions of any of its members

AN INVERTED SIPHON FOR THE ASSABET RIVER CROSSING OF THE WACHUSETT AQUEDUCT

BY STANLEY M. DORE*

[*Read September 16, 1948*†]

THE Wachusett Aqueduct of the Massachusetts Metropolitan Water District was first put into service 50 years ago, in 1898. It is twelve miles long: two miles in rock tunnel, three miles in open channel and seven miles in a grade-line aqueduct, built of concrete and brick masonry and covered with earth. It has a capacity of about 350 mgd. The grade-line aqueduct, except for the Assabet River Bridge Crossing, is horseshoe in shape, mainly 11 ft. 6 in. wide and 10 ft. 6 in. high, with an invert slope of one foot in 2,500 feet. The lower portion for 4 ft. 9 in. above the invert is built of a natural cement concrete, lined with brick, and the arch is built of Portland cement concrete, but with no brick lining. The grade-line aqueduct is carried across the Assabet River in the town of Northborough on a masonry bridge, constructed of concrete and faced with granite. The bridge consists of two abutments and six piers, the aqueduct being supported between them by seven stone-masonry arches, as shows in Figure 1. The top of the aqueduct, about 30 ft. above the river level, is covered with a promenade extending across the bridge for a distance of 329 ft. with steps at each end of the promenade.

The cross section of the aqueduct at the bridge is roughly rectangular, but the floor and the lower parts of the side walls are sloped and finished approximately to the same horseshoe and invert shape as those of the aqueduct on either side of the bridge. This roughly rectangular shape is lined with brick-work for the entire periphery of the cross section and, on the sides and bottom, a lead lining plate is built on the under side of the brick-work for watertightness.

---

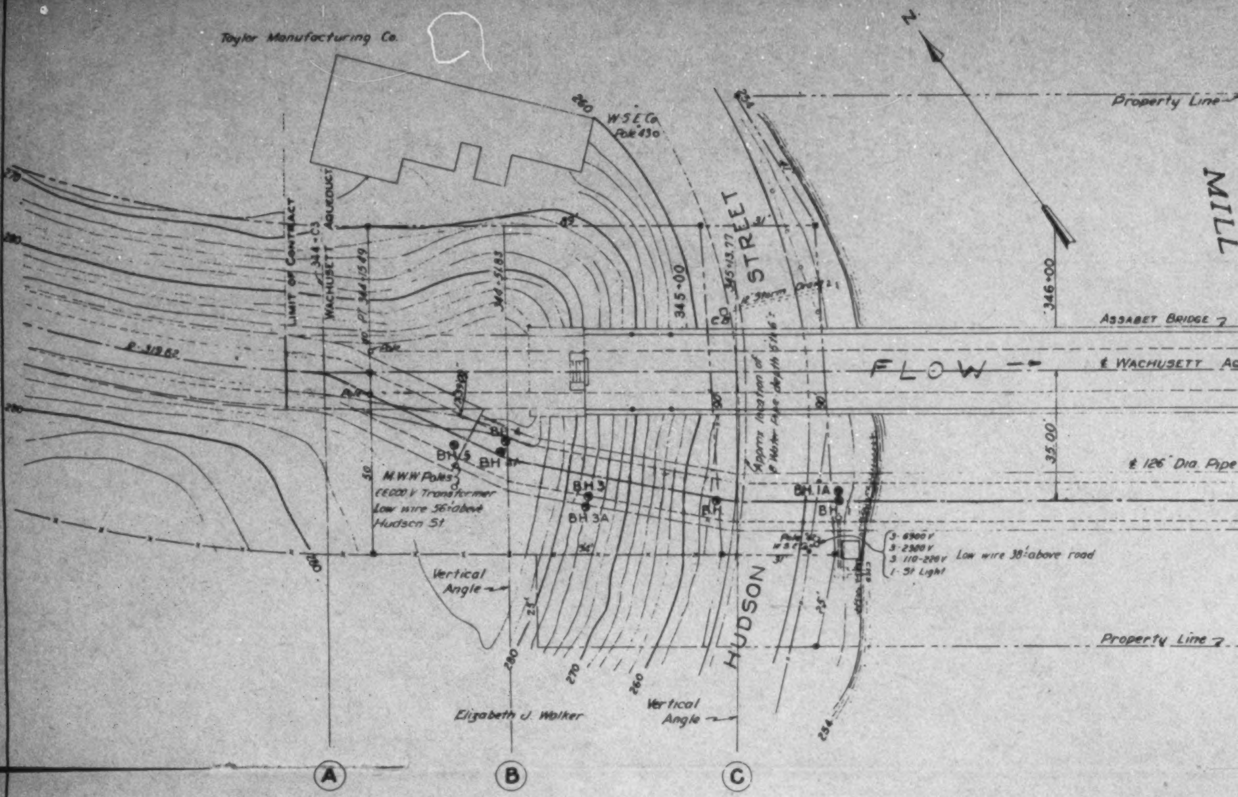
*Deputy Chief Engineer, Construction Division, Metropolitan District Commission, 20 Somerset St., Boston, Mass.

†The author gave a talk on the same subject before the Association on June 10, 1948.

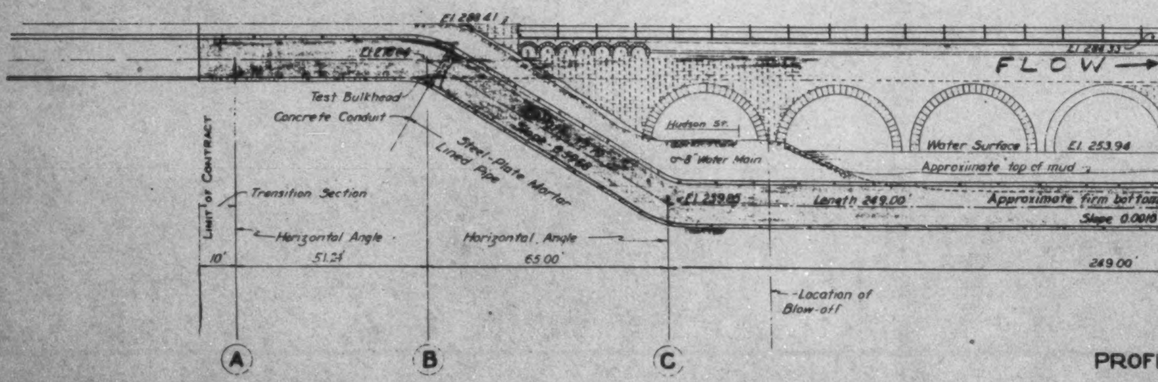
About 15 or 20 years ago, the aqueduct began to leak at the bridge crossing and this condition progressed until the leakage reached such proportion that in October, 1939, the Metropolitan District Water Supply Commission let a contract for the mortar lining of this section of the aqueduct at the bridge to the National Gunite Contracting Co. of Boston, Mass. The contractor prepared the interior surfaces of the aqueduct by removing all growths, deposits, scale, and loose or deteriorated remains by use of air, water and sand blasts and by cleaning, beveling and caulking all cracks. He then applied gunite 1½ in. thick, reinforced with wire mesh on the under side of the roof, and 1 in. thick, unreinforced, on the invert and side walls. This work was bonded into the brick-work at either end of the lined portion by removal of a groove of bricks around the periphery of the side walls and invert. Upon such removal it was found that the existing lead lining had become porous. The brick-work had been cracked to considerable degree at and below the under side of the roof, due, probably, to operation of the aqueduct at capacities sufficient to surcharge the roof slab. This guniting work was satisfactorily completed at a cost of $6,011.25.

Since this aqueduct is the only carrier of water from the District's supply in the Wachusett Reservoir, which water includes diversions from the Ware and Swift River developments, the work of lining the bridge was required to be done within a period of six days. After lining, the contractor cleaned and chlorinated the mortar lining, before the aqueduct was put into service, by spraying with a chemical solution. The contractor also conducted a satisfactory watertightness test at full working head for a 24-hour period.

Since 1940, and following the construction in 1939 of the works for diverting flow into the new Hultman (Pressure) Aqueduct—even though steel bellmouths had been installed in the Terminal Chamber of the Wachusett Aqueduct, to conserve head available for operation of the Hultman Aqueduct—cracks were again opened under the roof slabs. The leakage at the bridge became of such quantity as to be a nuisance, particularly in the winter time and


Taylor Manufacturing Co.
W.S.E. Co. Pole 43a
Property Line
MILL
LIMIT OF CONTRACT
WACHUSETT AQUEDUCT
344-C3
P.T. 344+15.49
344+51.93
345+00
345+13.77
346+00
STREET
HUDSON
Storm Drain
R-319.62
ASSABET BRIDGE
FLOW
℄ WACHUSETT AQ
35.00
℄ 126" Dia. Pipe
Approx. location of 8" Water Pipe
BH 5
BH 4
BH 3
BH 3A
BH
BH 1A
BH 1
M.W.W. Poles
6600 V Transformer
Low wire 56' above Hudson St.
3-6900 V
3-2300 V
3-110-220 V
1-St. Light
Low wire 38' above road
Vertical Angle
Vertical Angle
Elizabeth J. Walker
Property Line
280
270
260
254
A
B
C

PLA

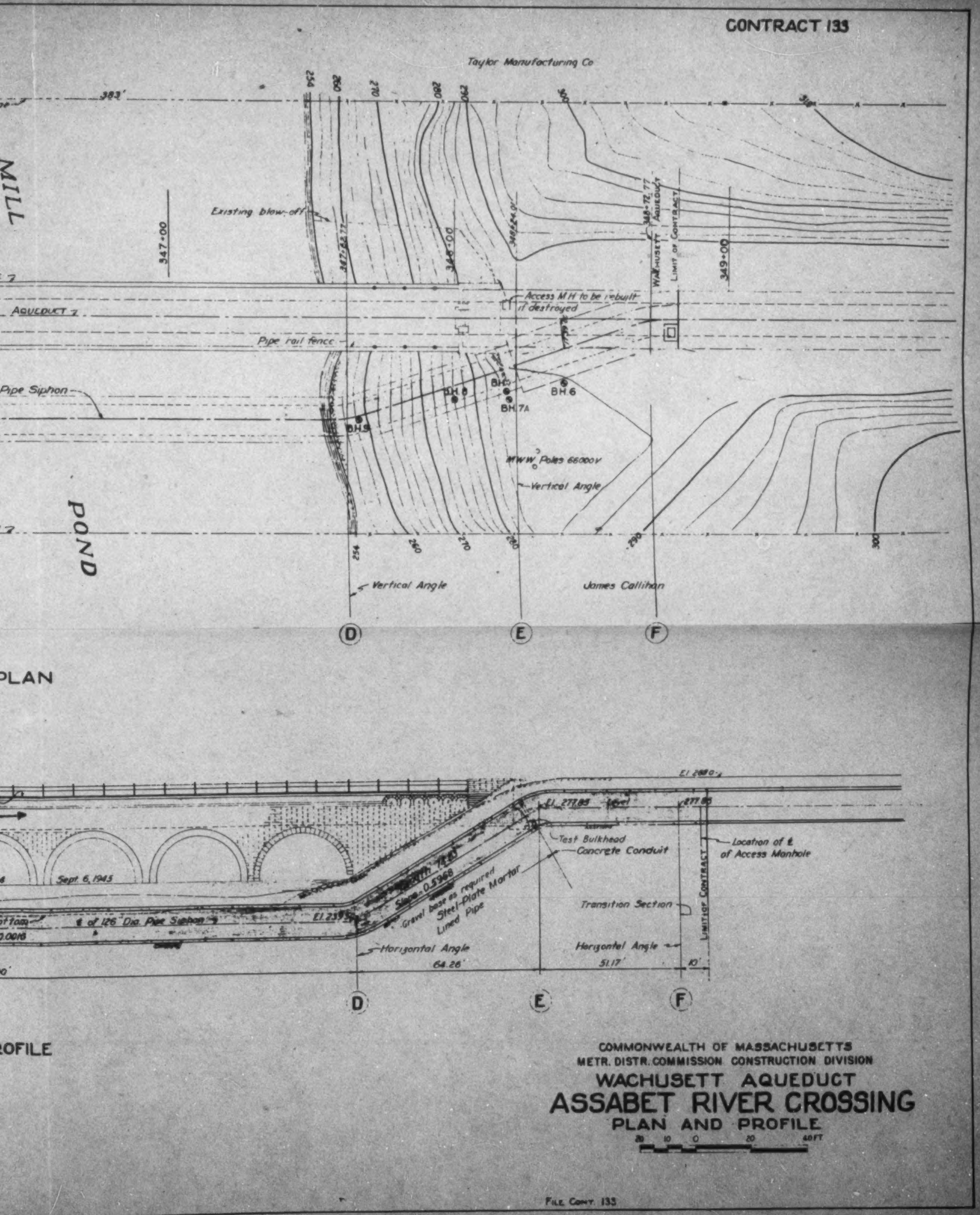

El. 280.41
El. 284.35
FLOW
Test Bulkhead
Concrete Conduit
Steel-Plate Mortar Lined Pipe
Hudson St.
8" Water Main
Water Surface
El. 253.94
Approximate top of mud
Approximate firm bottom
El. 259.85
Length 249.00'
Slope 0.0010
LIMIT OF CONTRACT
Transition Section
Horizontal Angle 51.24'
Horizontal Angle 65.00'
10'
249.00'
Location of Blow-off
A
B
C

PROF

Drawn J.F.C.
Traced J.F.C.
Checked

Stanley M. Dore
Ass't Chief Engineer

Karl R. Kennison
Chief Engineer


CONTRACT 133
Taylor Manufacturing Co
383'
254
260
270
280
290
300
310
MILL
POND
347+00
Existing blow-off
347+84.77
348+00
348+24.01
348+72.77
WACHUSETT AQUEDUCT
LIMIT OF CONTRACT
349+00
AQUEDUCT
Access M H to be rebuilt if destroyed
Pipe rail fence
Pipe Siphon
BH.9
BH.8
BH.7
BH.7A
BH.6
MWW Poles 66000V
Vertical Angle
Vertical Angle
James Callihan
D
E
F
PLAN
El 288.0
El 277.85
277.85
Sept. 6, 1945
of 126" Dia. Pipe Siphon
0.0016
El 239
Length 71.63
Slope 0.5968
Gravel base as required
Steel-Plate Mortar Lined Pipe
Test Bulkhead
Concrete Conduit
Location of ℄ of Access Manhole
Transition Section
LIMIT OF CONTRACT
Horizontal Angle
Horizontal Angle
64.26'
51.17'
10'
D
E
F
PROFILE
20 10 0 20 40 FT
FILE CONT. 133

COMMONWEALTH OF MASSACHUSETTS
METR. DISTR. COMMISSION CONSTRUCTION DIVISION
WACHUSETT AQUEDUCT
ASSABET RIVER CROSSING
PLAN AND PROFILE

FIGURE 1

freezing weather, where the bridge crossed a main highway. Also some disintegration of mortar had begun in the joints of the stone work, due to the alternate freezing and thawing of leakage trickling down through the stone facing. In addition, bombing activities and sabotage in other countries during the war called attention to the particular vulnerability of this bridge structure, carrying the main supply aqueduct of the District, to malicious damage in times of hostilities or internal disorders. For these reasons the Commission decided to abandon the grade-line bridge crossing and carry the water in Wachusett Aqueduct under the Assabet River by an inverted pipe siphon. Complying with a request of the selectmen of the town of Northborough, urging that the Commission preserve the "beauty and magnificence" of the granite Assabet Bridge, the Commission voted to let the viaduct stand and did not further consider its demolition after construction of the siphon.

A contract for constructing the pipe siphon was executed with Berke Moore Company, Inc., Boston, Mass., on August 28, 1946, at the bid price of $197,758.

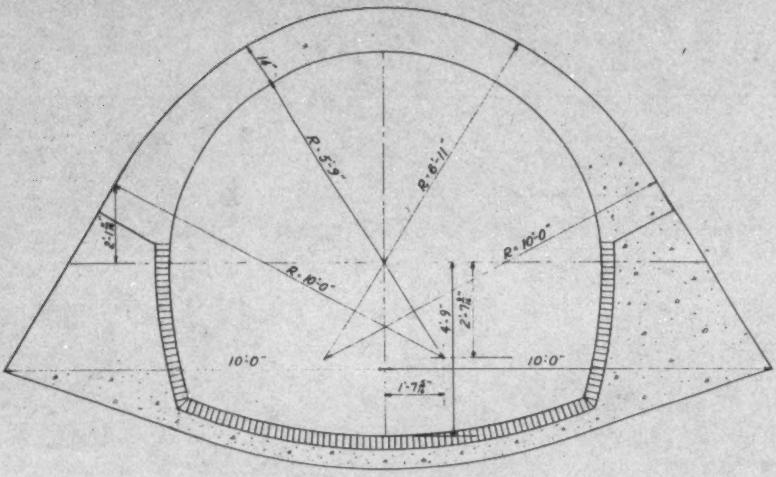
This siphon, about 480 ft. long, consists of a ½-inch steel-plate pipe, 10 ft. 7½ in. in diameter, encased in concrete and mortar-lined with gunite, which is reinforced with wire mesh; except that, where the connections at the ends of the siphon break into the existing aqueduct, the construction is of reinforced-concrete masonry without the steel cylinder, because the head is low. Typical sections of the siphon are shown in Figure 2.

The first work done under the contract consisted of water control of the Assabet River and of the mill pond at the site, which work was started in the late summer. The Gothic Craft Mill Dam, just down stream from the site, was breached to lower the mill pond, and a diversion channel was excavated and paved with riprap. Mud from the bottom of the pond was excavated and placed as an upstream cofferdam, and two 36-in. corrugated-iron pipes were built in the cofferdam and carried over the proposed siphon location through one of the arches of the existing bridge, the pipe being suspended from 16-in.-by-16-in. timbers, which spanned the trench location. The downstream end of these pipes discharged on the downstream side of the existing bridge, and water was controlled to flow through the pipes and through existing and prepared channels to the breach in the dam. A small cofferdam of sand bags was built on the downstream side of the bridge. A Moretrench wellpoint system was then installed, consisting of 129 2-in. wellpoints, 16 ft. long, attached to an 8-in. collecting line which, in turn, was connected to two 8-in., 2,500-gpm, Fairbanks-Morse centrifugal pumps. The water collected was deposited on the downstream side of the sand-bag cofferdam below the bridge. This main system was supplemented by a small, individual, similar wellpoint system, consisting of 21 wellpoints and one 8-in., 2,500-gpm pump, for further ground-water control on the easterly slope.

In the early fall, after the ground-water situation was under satisfactory control by the wellpoint system, wooden sheeting was driven adjacent to the abutments of the existing bridge and the excavation of the trench was done. Screened gravel was placed in the bottom of the excavated trench during October and a concrete mat, upon which the pipe was to be laid, was then poured over the gravel.

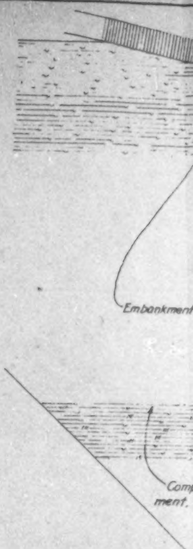
Steel-plate pipe was fabricated by the Bethlehem Steel Co. at its shop in Steelton, Pa., in lengths of about 33 to 34 ft., with three welded longitudinal joints and with butt-riveted girth joints. These lengths were shipped by rail uncoated (the ends of each pipe being supported by spiders and struts to prevent injurious deflections during handling) to a nearby siding, where they were unloaded by a traveling crane and transported on truck trailers to the site. The butt strap was split at the horizontal diameter, the lower half being riveted to each pipe section in the shop. The pipe was laid on blocking and the remainder of each joint field-riveted. Strap anchors were welded to the pipe shell, to give bond between the steel plate and the concrete envelope.

The pipe was placed in the work by a stiff-leg derrick, movable along and operated from the promenade on the Assabet River Bridge, as shown in Figure 3. These lengths of pipe (about 140 tons total) were placed on blocks, riveted and caulked, and, after the portion of the concrete envelope under the pipe had been poured, a 24-hour field test for watertightness was satisfactorily completed on December 19, 1947, the actual leakage under hydrostatic pres-



14"
R. 5'-9"
R. 6'-11"
2'-1½"
R. 10'-0"
R. 10'-0"
4'-9"
2'-7½"
10'-0"
10'-0"
1'-7⅞"

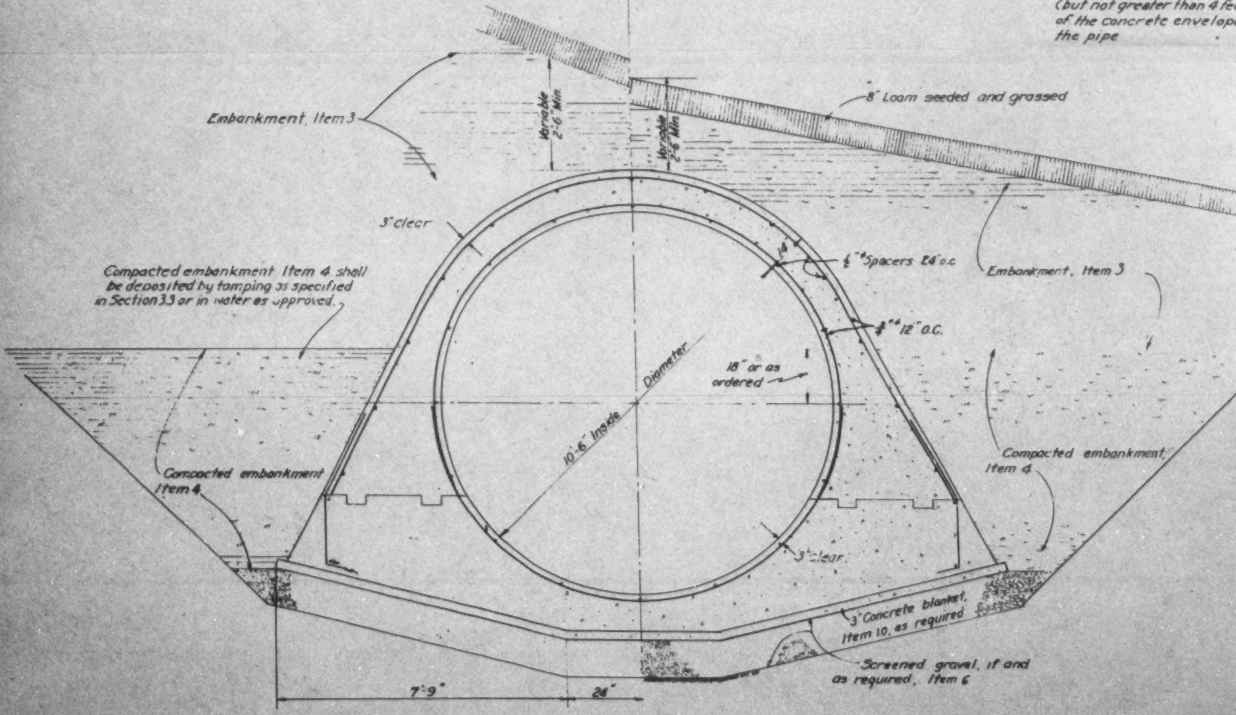
EXISTING WACHUSETT AQUEDUCT



Embankment
Comp
ment.

② A second lift of concret
envelope may be poured as
shown by permitted Constr
Joints

① Approved supports sh
(but not greater than 4 fe
of the concrete envelop
the pipe



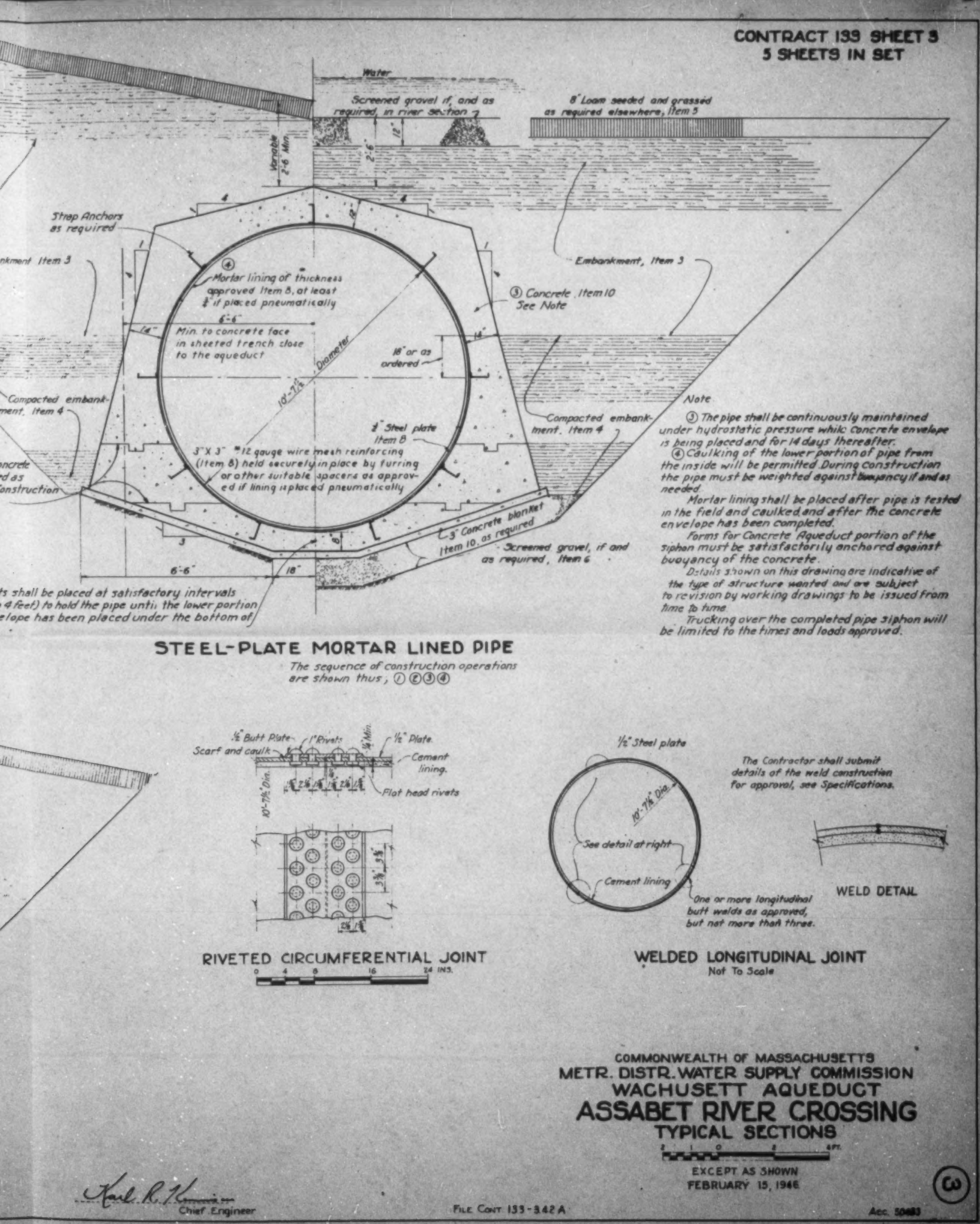
Embankment, Item 3
Variable 2'-6" Min.
Variable 2'-6" Min.
8" Loam seeded and grassed
3" clear
14"
½" ϕ Spacers 24" o.c
Embankment, Item 3
Compacted embankment Item 4 shall be deposited by tamping as specified in Section 33 or in water as approved.
¾" ϕ 12" O.C.
18" or as ordered
10'-6" Inside Diameter
Compacted embankment Item 4
Compacted embankment, Item 4
3" clear.
3" Concrete blanket, Item 10, as required
Screened gravel, if and as required, Item 6
7'-9"
24"

CONCRETE AQUEDUCT

Drawn J.E.C.
Traced J.E.C.
Checked

Stanley M. Dore
Ass't. Chief Engineer

CONTRACT 133 SHEET 3
5 SHEETS IN SET


Water
Screened gravel if, and as required, in river section
8" Loam seeded and grassed as required elsewhere, Item 5
12"
2'-6"
Variable 2'-6" Min.
Strap Anchors as required
nkment Item 3
Embankment, Item 3
④ Mortar lining of thickness approved Item 8, at least ¾" if placed pneumatically
③ Concrete, Item 10 See Note
6'-6"
14"
Min. to concrete face in sheeted trench close to the aqueduct
14"
18" or as ordered
10'-7½" Diameter
Compacted embankment, Item 4
Compacted embankment. Item 4
½" Steel plate Item 8
3" X 3" #12 gauge wire mesh reinforcing (Item 8) held securely in place by furring or other suitable spacers as approved if lining is placed pneumatically
ncrete
d as
onstruction
3" Concrete blanket Item 10, as required
Screened gravel, if and as required, Item 6
6'-6"
18"
ts shall be placed at satisfactory intervals
4 feet) to hold the pipe until the lower portion
elope has been placed under the bottom of
½" Butt Plate
1" Rivets
¼" Min.
½" Plate
Scarf and caulk
Cement lining.
10'-7½" Dia.
Flat head rivets
½" Steel plate
10'-7½" Dia.
See detail at right
Cement lining
One or more longitudinal butt welds as approved, but not more than three.
0 4 8 16 24 INS.
2 1 0 2 4 FT.

Note

③ The pipe shall be continuously maintained under hydrostatic pressure while concrete envelope is being placed and for 14 days thereafter.

④ Caulking of the lower portion of pipe from the inside will be permitted. During construction the pipe must be weighted against buoyancy if and as needed.

Mortar lining shall be placed after pipe is tested in the field and caulked, and after the concrete envelope has been completed.

Forms for Concrete Aqueduct portion of the siphon must be satisfactorily anchored against buoyancy of the concrete.

Details shown on this drawing are indicative of the type of structure wanted and are subject to revision by working drawings to be issued from time to time.

Trucking over the completed pipe siphon will be limited to the times and loads approved.

STEEL-PLATE MORTAR LINED PIPE

The sequence of construction operations are shown thus; ① ② ③ ④

The Contractor shall submit details of the weld construction for approval, see Specifications.

WELD DETAIL

RIVETED CIRCUMFERENTIAL JOINT

WELDED LONGITUDINAL JOINT
Not To Scale

COMMONWEALTH OF MASSACHUSETTS
METR. DISTR. WATER SUPPLY COMMISSION
WACHUSETT AQUEDUCT
ASSABET RIVER CROSSING
TYPICAL SECTIONS
EXCEPT AS SHOWN
FEBRUARY 15, 1946

Karl R. Kennison
Chief Engineer

FILE CONT 133-342 A

Acc. 50483

③

FIGURE 2

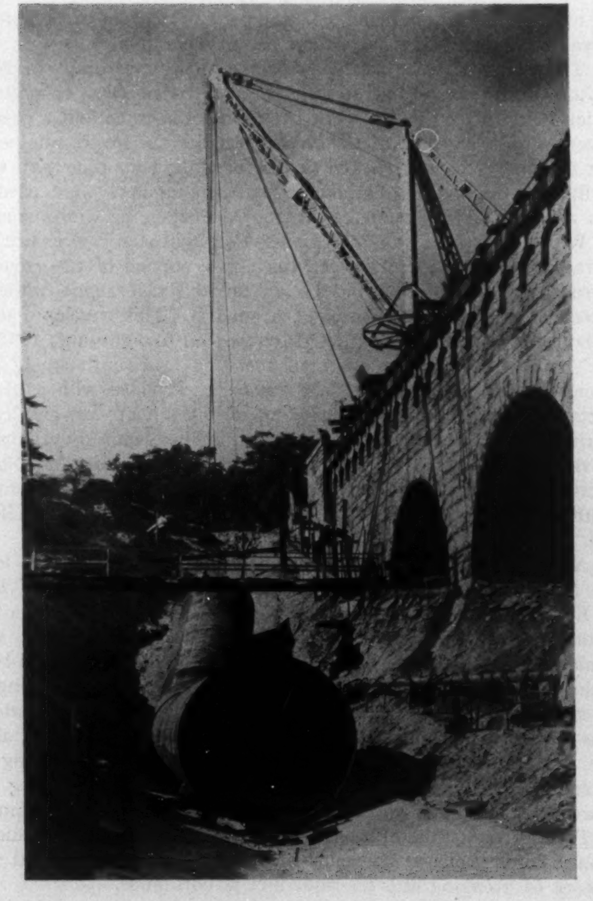


FIG. 3.—PLACEMENT OF PIPE FOR ASSABET RIVER SIPHON BY MEANS OF STIFF-LEG DERRICK (*Photo Barbier*).

sure of 48 lb. per sq. in. being 0.53 gal. per day per foot of siphon—the allowable leakage being one gallon per day per foot.

The concrete was obtained from a ready-mix plant in North Grafton and transported in transit-mix trucks, the concrete on the job being placed in the work by means of a crane and a concrete bucket. The lower part of the envelope under the invert was poured after the pipe had been riveted and before filling the pipe with water for the tightness test. Tarpaulins and salamanders were used for heat, as most of the concrete was poured during the winter months.

While the pipe was still under the hydrostatic pressure, the contractor was required to place the upper portion of the envelope, in order that the pipe would be an inflated true shape while the concrete in the envelope hardened around it. This envelope, shown in Figure 4, was nearly completed by the end of February, 1948.

The wellpoints were operated more or less continuously until the envelope was completed. The siphon is provided with a blowoff structure, which permits the draining of the siphon, by gravity, to the river level through a 16-inch cast-iron line, with provisions for inserting a pump suction for further unwatering. In this blowoff structure a connection is provided, so that the town of Northborough, or others, may be furnished with water from the aqueduct, if desired.

As the construction of the envelope progressed, the forms were removed and the trench was backfilled to the river-bed level.

Early in March, 1948, the National Gunite Co., under a subcontract, set up platforms and staging and proceeded with the work of lining the interior of the siphon. This work consisted of sand-blasting the interior surface, welding steel rods to the pipe for holding the wire-mesh reinforcing, installing of reinforcing, placing of interior forms or screeds, and placing of the gunite cement-mortar lining, about ¾ in. in total thickness, in two layers. The work of mortar lining was completed early in May. While the work of the mortar lining progressed, the cofferdams and the corrugated metal pipes were removed.

The contractor then placed the forms for the reinforced-concrete masonry connections at the ends of the siphon and proceeded with the work of breaking into the aqueduct at both ends.

About May 10, the contractor broke into the main aqueduct line.

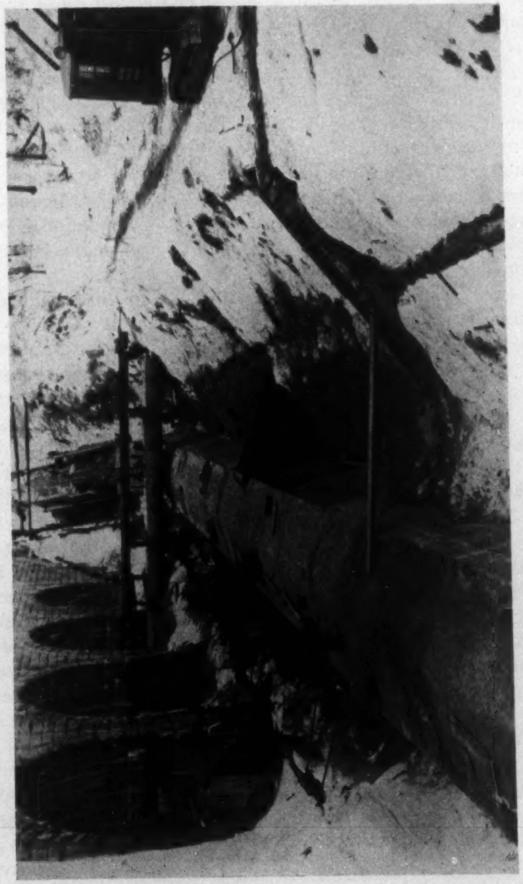


FIG. 4.—CONCRETE ENVELOPE AROUND ASSABET RIVER SIPHON (*Photo Barbier*).

He drilled holes through the arch and sidewalls and broke the arch by dropping a weight upon the masonry. The lower sidewalls and invert were broken up with a compressed-air hammer.

The flow in Wachusett Aqueduct was stopped for a period of about three days, to permit the breaking-in operations and the installation of the two temporary bypassing siphons, one at each abutment, after which period the contractor was required to permit the flow of not less than 70 mgd for the period of the construction of the connections, such flow being required so that the District's distribution reservoirs would not be overtaxed unduly during this latter period. The contractor was required to conduct his work in such manner that this limited-flow period would not exceed 30 days.

To effect such bypassing he constructed, upstream and downstream from each break-in location, brick bulkheads about 16 to 24 in. thick, braced with timber struts anchored to pins in the floor and walls of the aqueduct, through which bulkheads there were installed ¼-inch steel-plate siphons, each about 80 ft. long (see Figures 5 and 6). For the westerly or upstream break-in, the upstream bulkhead was about 10 ft. high and the downstream bulkhead about 8 ft. high; and for the easterly break-in, the upstream bulkhead was about 8 ft. high and the downstream about 7.5 ft. high. Each siphon consisted of a 42-in.-diameter throat section about 20 ft. long, a gradual reducing upstream section 54 in. to 42 in., about 10 ft. long, and a gradual enlarging downstream section 42 in. to 54 in., about 10 ft. long. The remainder of each siphon was generally 54 in. in diameter, with entrances and exits of special shapes flaring to what might be described, non-technically, as rectangular ellipses. The tapered sections downstream largely recovered the velocity heads generated in the throat and the tapered sections upstream were supplemented by specially shaped intakes and guiding vanes on the entrances, to minimize the entrance and change-in-section losses.

The elevations of the upstream and downstream ends were fixed low enough to be well below the operating water levels, so that the bypasses would be self-priming and act as siphons, as soon as the flow in the aqueduct was increased to the proper rate, although each might act as a flume before the tailwater levels were increased sufficiently to permit priming.

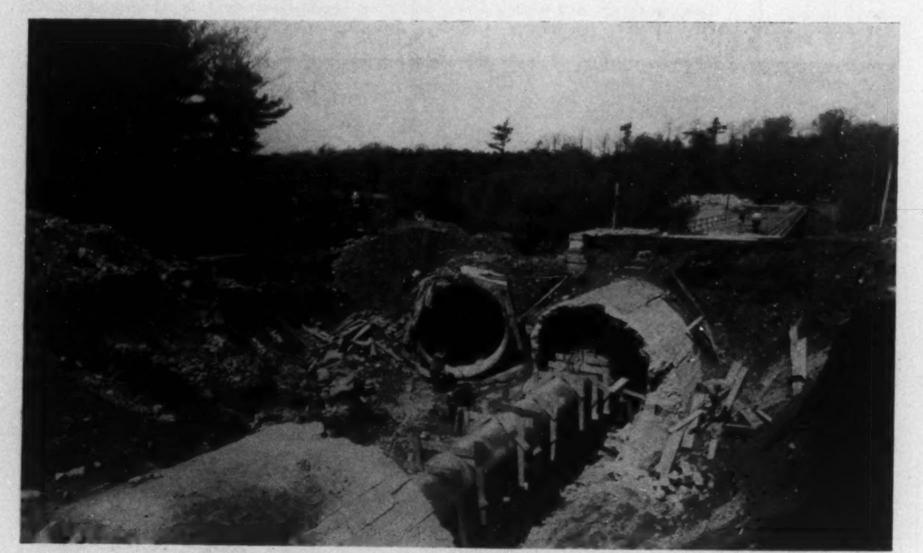


FIG. 5.—VIEW SHOWING EAST END OF STEEL-PIPE SIPHON (center background) BEFORE CONNECTION WITH WACHUSETT AQUEDUCT (left foreground); TEMPORARY SIPHON BYPASS IN CENTER FOREGROUND (*Photo Barbier*).

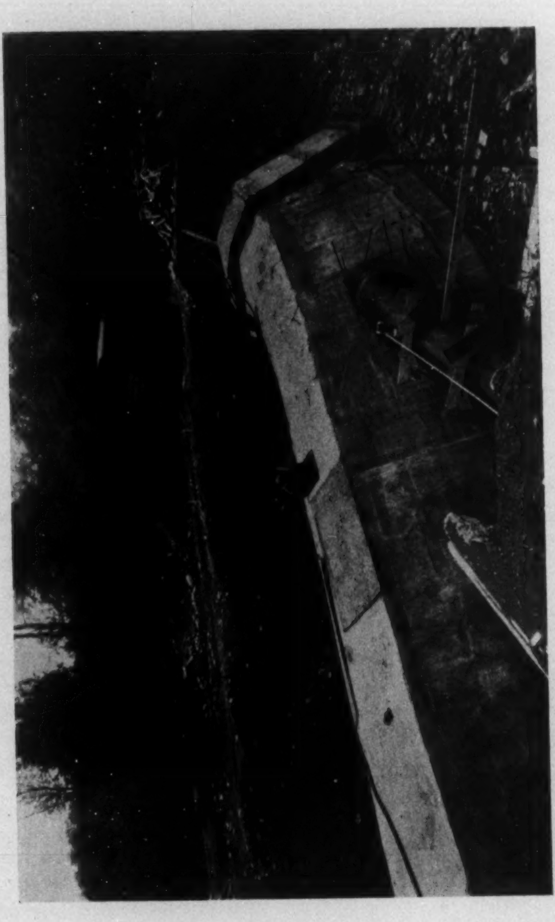


Fig. 6.—View Showing West End of Reinforced-Concrete Connection between Assabet River Siphon and Wachusett Aqueduct; Temporary Siphon Bypass in Right Foreground (*Photo Barbier*).

As an added precaution a vacuum pump, capable of sucking either air or water, or both, was required to be connected to the reduced section, to insure that each bypass remained continuously primed in case of an unforeseen contingency tending to endanger self-priming and complete siphonic carrying capacity.

Each bypass ran between its upstream bulkhead and downstream bulkhead and remained in place while the contractor built the reinforced-concrete masonry connection, the bypass at the smaller throat diameter passing through the new masonry wall of the siphon connection. Upon completion of the concreting, the bypasses and bulkheads were removed. The section of bypass pipe passing through the new concrete wall was burned off with a torch and the opening filled with a reinforced-concrete masonry plug, bonded to the adjacent wall by reinforcing left projecting for that purpose (see Figure 6).

An examination of the interior surfaces of the aqueduct after 50 years of service revealed that the surfaces were covered about ⅛ of an inch thick with a black decayed vegetable accumulation, slippery and in appearance like a heavy wet soot or mucky peat deposit.

Under this coating the brickwork lining was in excellent condition, only a slight decomposition of the surface of the mortar in the joints being evident. The Portland cement concrete surface, when dug into with a jackknife, showed that for a depth of about 1/16 of an inch the mortar was rather soft and discolored to a brownish shade, evidently from vegetable acids from the growths on the surface. Under this rather soft coat the concrete appeared to be in good condition, with no apparent signs of depreciation or disintegration.

The concrete in the arch was somewhat brittle to the bit when drilled, but the concrete in the natural cement concrete of the sidewalls and invert was described as "dead"—that is, it drilled more like an extremely compact till, due, probably, to its complete saturation during many years of service. After the break dried out, this concrete would exhibit the same brittle drilling characteristics as ordinary concrete. Its condition otherwise was sound, with little or no evidence of disintegration or deterioration.

The capacity of the temporary bypasses was estimated as follows:

	Water elevations (ft)					
	At bypasses					
Rate (mgd)	Upstream	Between	Down-stream	At control intake dam located about 3 mi downstream	Velocity in throat of bypass (ft per sec)	Vacuum (ft)
85	282.0	280.65	279.3	279.2	13.5	5 ±
100	282.0	280.1	278.2	278	16	5.5±
120	282.0	279.25	276.5	275	19	6.5±

The bypasses worked efficiently, being self-priming and passing substantial quantities of water with small losses of head.

The contractor completed the construction of the siphon connections in 28 days and again the flow in the aqueduct was suspended for 3 days, while he removed the bulkheads and bypasses and concreted the holes in the sidewalls of the connections, through which the bypasses had been constructed. At this time the siphons, connections and adjacent sections of the Wachusett Aqueduct were chlorinated.

Water from Wachusett Reservoir was then released into the aqueduct and the inverted siphon put into service. The total loss of head through this aqueduct siphon in a distance of about 400 ft. is less than 0.2 of a foot more than the drop in the invert along the old viaduct for this same distance.

The work was planned, designed and constructed by the Construction Division of the Massachusetts Metropolitan District Commission: William T. Morrissey, Commissioner, and William F. Rogers, Joseph McKenney, Max Ulin and John J. Grigalus, Associate Commissioners.

Karl R. Kennison is Chief Engineer of the Construction Division, the writer, Deputy Chief Engineer, and Frederick W. Gow, Division Engineer. In immediate charge of this project were Chester J. Ginder, Senior Civil Engineer, on design and office work and Edmund T. Carey on construction supervision.

DISCUSSION

W. S. FOSTER. I was interested in Mr. Dore's statements about the existing concrete that has been there for 50 years. I understand that was Portland cement concrete. Was there a blend of natural cement with it? Would you say that that had any structural value particularly, or have you any thoughts about its structural value?

Stanley M. Dore. The cross-section was built of two kinds of concrete. The arch, under which there was no lining, was a Portland cement concrete. The side walls were lined with brick and outside the brick was the natural cement concrete. The Portland cement concrete, being in the upper part, was probably not as saturated as the natural cement concrete would be below the water line. I think the evidence from inspection shows that the Portland cement concrete was in a little better shape than the natural cement concrete was. I think you would expect that anyway, because the Portland cement concrete was not under the pressure that the natural cement concrete was. When it dried out, there was not any evidence of lack of brittleness. It was just because it was saturated.

Mr. Foster. That would carry a load in weight, however?

Mr. Dore. Yes. Of course it was back-filled. There was no indication of lack of strength; just lack of brittleness.

RECENT LABOR LEGISLATION AND ITS EFFECTS ON PUBLIC UTILITY OPERATIONS

BY JOHN H. MURDOCH, JR.*

[*Read September 14, 1948.*]

In a paper of reasonable length it is impossible to cover the entire field of "recent labor legislation" and an attempt at such a coverage would be uninteresting. Consequently, discussion will be limited to the two most important Federal statutes—namely, the Fair Labor Standards Act and the Taft-Hartley Act—and two State statutes, which are of interest as indicating a public reaction to conditions in the field of employee relations with public utilities. The two State laws commented upon are those of New Jersey and Pennsylvania.

The majority of those who will either hear or read this paper will be non-lawyers, not interested in long quotations and in the citation of authorities. For that reason the presentation will be limited to statements of what the writer believes to be the presently accepted understandings of the meanings of the laws, followed by his opinions of what effects those laws, as so understood, have on utility operations. It should be noted that accepted understandings of the meanings of the laws do not necessarily coincide with the ideas of the author.

FEDERAL FAIR LABOR STANDARDS ACT

Coverage of the Act

The Fair Labor Standards Act became law in 1938, while the country was still suffering from the depression, when unemployment was general and wages were low. The law was designed to improve conditions by requiring all interstate-commerce commodities to be produced under such restrictions that there would be a floor under hourly wage rates and a penalty, through the imposition of premium hourly wage rates, against long weekly work periods. It is probably true that the latter provision was inserted primarily to spread work, by making it desirable for employers to work more employees fewer hours a week. As the Act is drawn the tests, in practically all cases, of whether an employee is covered—that is, has the benefit of the Act—are based on the employee's own personal activities and not on the nature of the employer's business. *First,* employees who are engaged in interstate commerce are covered. An illustration would be a man who works at a utility meter shop, unloading and storing meters shipped across State lines. *Second,* employees engaged in the production of goods for interstate commerce are covered. A case of this might be an employee who works in a pipe foundry in Alabama, making molds for pipe to be shipped to Florida. He would be covered because his activities are in the production of goods for interstate commerce, although his employer may so conduct his business that he—the employer—is not technically engaged in interstate commerce. *Third,* by statutory definition, an employee is "producing goods" for interstate commerce if he is engaged in an activity "necessary to the production of goods" for such commerce. Assume a case in which a water-utility employee had the job of maintaining a line of water pipe leading into a pipe foundry in Alabama, that the water was convenient in connection with, but not essential for, the operation of the foundry, that some of the pipe produced in the foundry was shipped to Florida. With those facts the water-utility maintenance man would be entitled to the benefit of the Fair Labor Standards Act. However, a meter reader of the same utility, engaged exclusively in reading domestic meters, would not be covered. The meter reader's activities were not in interstate commerce or in the production of goods for commerce. In summary, the test of coverage lies in the activity in which the individual employee is engaged.

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*Vice President and Counsel, Water Works Service Company, Inc., 50 Broad St., New York 4, N. Y.

An important point as to coverage is of particular interest to water utilities. Under the definitions in the Act, the United States, the States, and political subdivisions of the States are not employers. As it is estimated that more than 85% of all water-supply agencies in the United States are owned by municipalities, we have the strange situation of a statute designed to prevent unfair interstate competition applicable only to a minor segment of a vital enterprise.

It is probable that most privately owned, public water-supply agencies have employees who are covered by the terms of the Act, and it is certainly true that no public water-supply agency wholly owned and controlled by the United States, or by a State, or by a political subdivision of a State has any employees covered by the Act. However, as will be developed later, the operations of all water-supply agencies are affected by it.

Wage Standards

The Act set up a sliding scale of minimum wages, advancing by steps until the present minimum was reached on October 24, 1945. That present minimum hourly wage rate is $.40; the starting minimum in 1938 was $.25. For most types of employment both these minimum rates are of mere antiquarian interest.

Hours of Work

While the Fair Labor Standards Act may be said to frown upon long hours of work, the only specific evidence of disapproval is a provision for premium pay for hours worked in excess of 40 in a work week. There is no prohibition of a long work day and no prohibition of a long work week, but the employer is penalized for a long work week by being required to pay 1½ times the regular rate of pay for all hours worked in the work week in excess of 40. Thus, when labor supply is plentiful, the result is a spreading of work among more employees and, when there is more work to be done than there are workers available, the result is a long work week with premium or penalty overtime wages.

The provisions of the Act in regard to overtime pay appear to be very simple, but in practice those simple provisions have proven to be extremely difficult. Improper computation of the hours of overtime and of the amount of pay due for such overtime accounts for most of the reparation orders issued by the Administrator. Confusion has been confounded by the recent decision of the United States Supreme Court in the Longshoremen's case, to the effect that the regular rate of pay on which the overtime premium pay is based must always be determined by calculation and cannot be spelled out by contract. The difficulties inherent in the overtime provisions and in the Longshoremen's decision are so involved and technical that no attempt will be made to discuss them further in this paper.

TAFT-HARTLEY ACT—LABOR-MANAGEMENT RELATIONS ACT, 1947

The Taft-Hartley Act is long and involved, and is now a major issue in the presidential election campaign. In the operation of a water utility, only a few of the provisions of the statute have been found of importance to either management or labor, and only such provisions will be commented upon in this paper. The effort will be made to offer a factual presentation without expression of the opinions of the writer.

Coverage of the Act

The Taft-Hartley Act differs from the Fair Labor Standards Act in its coverage. The two have one point of similarity in this respect, inasmuch as both except the Government, the States and Municipalities from the definition of "employer". Thus, again the statute has direct application only to a minor segment of the waterworks field. The Taft-Hartley coverage, both as to employers and employees, and also as to third parties, is tested by the nature of the business of the employer rather than by the activities of the individual employee. If an employer is engaged in interstate or foreign commerce or in an enterprise of such nature that a labor dispute involving the business of the employer would "affect" such commerce, then the Act applies. In terms of the water-supply enterprise, this would bring under the coverage of the Act relations between management and labor of any non-municipal water-supply organization, if it buys, sells or transports across State lines or if it supplies water service to railroads or businesses which are in interstate commerce. As the Act is presently interpreted, the great majority of privately owned water utilities appears to be under the Act.

Collective Bargaining

Employees are protected in their right to organize, to engage in concerted activities, to bargain collectively through representatives of their own choosing and, also, to refrain from doing any of these things, except when there is a union-shop agreement made pursuant to a secret ballot election. Employers are likewise guaranteed the right to choose their own representatives for collective bargaining. Both management and labor are required to engage in good-faith collective bargaining, if the employees have chosen a representative to act for them. These mutual obligations in regard to collective bargaining are new features and constitute important changes from the Wagner Act. Under that Act the representatives of the employees could compel the employer to bargain in good faith, but were not required to bargain in return. In practice, this meant that the employer was always in the position of trying to reach agreement by interesting the representative of the employees, by offering more and more concessions, without the other party's being under any obligation to make counter-proposals. Only the employer was by law required to maintain an open mind.

When the new Act requires both parties to bargain collectively, it seems to contemplate that each side will be ready to listen fairly and to consider proposals with reasonable and open minds, with an intent to reach agreement. A merely negative attitude is not enough, although there is a specific statutory statement that a party is not required to agree to any particular suggestion.

Closed Shop—Union Shop

The Taft-Hartley Act makes it unlawful to require that an individual be a member of a labor organization before he may be employed by the employer. That is, the closed shop is no longer lawful and this provision is giving rise to bitter and protracted strikes. The closed shop has been a commonly accepted institution, for illustration, in the printing and the longshoremen unions, and the unions refuse to make new contracts without retaining at least the substance of the old conditions of employment. On the other hand, the Act does permit a union-shop agreement, under which all non-union employees must join the union within 30 days or face loss of employment. Such agreements may be made only with a chosen representative of the employees and by such representative only after a majority vote, with secret ballot, if the unit has authorized the agreement. Where such elections have been held by the National Labor Relations Board under the Act, the great majority has resulted in authorization of the union-shop agreement. However, some unions are so bitter about the entire Act that their officers refuse to ask for such elections. Other unions fail to act because their officers are unwilling to qualify by taking the required oath that they are not Communists.

So far as the writer can learn, formal closed-shop arrangements have not been common in the water-works field, but there have been some union-shop agreements. There have been some elections under the Act in water-utility units and those elections have authorized the union-shop contracts. Some plants have had contracts under which the water-works management agreed to give preference to men recommended by the union and such provisions are no longer lawful. Whether there will be any trouble on this account is an open question.

Check-Off of Union Dues

An employer is authorized to deduct union dues from an employee's wages and pay the dues to his union only if he has received from the employee a written assignment, which shall not be irrevocable for a period of more than one year or beyond the termination date of the applicable collective agreement, whichever is sooner.

Concerning Strikes

When a collective bargaining agreement is in effect, the duty to bargain collectively continues. A party wishing to modify or terminate the agreement must give 60 days' written notice to the other party and must offer to meet and confer. If agreement be not reached in 30 days, then the moving party must notify the Federal Mediation and Conciliation Service, and any similar State agency, of the existence of a labor dispute. The existing contract must be continued in effect, without strike or lockout, for 60 days or until the termination of the existing contract, whichever is later. Any employee violating this provision by a strike loses his status as an employee.

Strikes to enforce a secondary boycott or to force an employer to assign work to certain employees or unions not certified for such work are unfair labor practices. They may be the subjects of cease-and-desist orders or, on motion of the Labor Board, the subjects for court injunctions.

Strikes which do or might imperil the national health or safety may be made the subject of inquiry by a Presidential Board and may subsequently be enjoined by the courts for a period of 80 days. At the end of the 80-day period the strike may go forward. Because of the national viewpoint required, this provision is of doubtful value to the typical local water plant.

PENNSYLVANIA PUBLIC UTILITY LABOR-DISPUTES ACT

In 1947 the Pennsylvania legislature passed an Act virtually forbidding strikes or lockouts in public utilities. The Act was approved by the Governor and became law on June 30, 1947. Its enactment followed shortly a long, bitter strike of electric company employees in Pittsburgh, which truly crippled its citizens and industries and imposed not only inconvenience but hardship on the people of the city. That strike and the well grounded fear of others to follow left the people of the State in no mood to tolerate a situation where either management or a few labor leaders could freely jeopardize the life of the community. Neither the companies nor the unions wanted legislation or wanted the State to dictate terms and conditions of employment, but the public demanded action in its interest.

The legislation became law and the writer is informed that its compulsory arbitration provisions have never been invoked. He is also informed that since the law became effective there have been no utility strikes.

Summary of Essential Provisions of Act

The statute makes it the duty of public utility employers and employees "to exert every reasonable effort to settle all labor disputes by engaging in collective bargaining in good faith and by entering into agreement and maintaining the same." A Labor-Management Advisory Committee, composed of representatives of both labor and management in equal numbers, is to supply the Governor with a roster of recommendations for an Arbitration Panel of 12 persons. In case a labor dispute finally goes to state arbitration, a board of three arbitrators is to be appointed for the case by the Governor from the Arbitration Panel.

Whenever, in a labor dispute involving a public utility, the collective bargaining process reaches stalemate, then either party or the Pennsylvania Labor Relations Board may request the Governor to appoint a mediator. The mediator, if appointed, attempts to bring the parties into agreement and, if unsuccessful, gets the best offer from each. The employer's best offer is submitted for secret ballot vote to all the employees in the unit. If accepted the dispute is settled; otherwise the negative vote constitutes a vote in favor of arbitration. If arbitration is so decided on, the matter goes to arbitration either under a contract or before a board appointed by the Governor. The award or decision of the board is filed in the court records and is binding on the parties for one year from such filing. Either party may appeal an award to the courts. From the time the Governor appoints a mediator until the termination of the procedure under the Act, strikes or lockouts are illegal. Individual employees acting independently of other employees are free to cease working.

The Act seems designed to put a premium on successful collective bargaining and to make it important for all parties to learn how to negotiate, with a view to mutually satisfactory settlements. The public, as represented by the State, has expressed a determination not to suffer through public utility strikes.

Strikes by Public Employees in Pennsylvania

The Public Utility Labor-Disputes Act has no application to employees of the State or its various subdivisions. However, on the same day that Act was approved the Governor also approved an Act making it illegal to strike in public employment. This latter Act would cover employees of municipal water plants. Provision is made for hearing and settlement of labor disputes, but an employee who wilfully fails to do his work is on strike and has terminated his employment.

The author has been unable to learn of any public employee strikes in Pennsylvania since June 30, 1947.

NEW JERSEY LABOR DISPUTES IN PUBLIC UTILITIES ACT

The State of New Jersey in 1947, by the enactment of new laws amending and supplementing then existing statutes, created an elaborate and interesting scheme for the regulation of public utility employee relations. The new laws have been the subject of litigation for more than a year in connection with the Bell Telephone strike of 1947 and a court decision was handed down on September 10, 1948, holding the law to be constitutional, contrary to the contentions of both the company and the unions. Unfortunately, the writer has been unable to secure a copy of the opinion of the court, so that his only knowledge concerning it comes from a rather brief newspaper account. The decision will probably be appealed and the rulings of higher courts on the points involved may well point out the lines for future attempts at solving the difficult problem of strikes affecting essential public service.

Very briefly summarized, the New Jersey Acts do the following:

(1) Make a legislative declaration that public utility services are life essentials of the people, that the threat of labor strife in public utility operation is a threat to the welfare and health of the people, and finally that state regulation of labor relations in the utility field is necessary in the public interest.

(2) Establish a scheme of labor-management relations similar to that of the Federal Labor-Management Relations Act at the State level. This scheme includes provision for a 60-day notice of desired changes in labor contracts or relations.

(3) Make provision for referring utility labor disputes to the State Board of Mediation, then to arbitration by a Public Hearing Panel, with public hearings followed by a written report to the Governor, containing a resumé of the evidence and the Panel's recommendations. This provision takes effect if the parties do not settle their disputes directly or agree to a private arbitration.

(4) Provide that if either party refuses to accept and abide by the recommendations of the Public Hearing Panel or if a strike occurs at any stage and the Governor determines that the continued operation of the utility is threatened or interrupted and that public interest, health and welfare are threatened, then the Governor may seize and operate the utility as a State facility operated as a governmental function of the State.

(5) State that after State seizure the relations between the State and the persons working in the affected utility enterprise are those of employer and employee.

(6) Declare that strikes or concerted refusals to work for the State after seizure of the utility by the State are unlawful, but that individuals may not be compelled to work when they act as individuals and not by concerted arrangement.

(7) Provide that within 10 days after a utility is seized by the

Governor a Board of Arbitration is to be set up, which then is to hold hearings and make findings of fact and orders on the issues submitted. The orders of the Board, unless changed on appeal, are conclusive and binding for one year.

(8) Make the provision that strikes, lockouts or refusal to abide by the terms of an order of the Board of Arbitration are subject to very severe penalties.

This New Jersey law is important and deserves study by all those concerned with employee relations and the public service. New Jersey is a highly industrialized State and utility strikes have immediate and widely spreading effects and do jeopardize the health and welfare of large communities. No such strike can be looked upon as merely a private dispute between an employer and his employees. The public interest is directly involved.

The writer has been furnished by an attorney in New Jersey, who does not wish to be named, with a summary of the records of proceedings under this statute. This summary was developed with the assistance of the staff of the New Jersey State Board of Mediation and is attached to this paper as an Appendix. Thanks are here extended to these friends in New Jersey for their help. The summary shows that the Act has been frequently invoked and applied and that it seems to have accomplished the result of minimizing interruptions of public service.

As previously mentioned, the Act has now been made the subject of a court decision in a Bell Telephone case. That decision was rendered by a judge of high character and ability, whose fairness and courage are generally recognized in the State. As reported in the newspapers, Vice-Chancellor Bigelow declared the plant-seizure and compulsory arbitration provisions of this law to be constitutional. This decision was handed down on September 10, 1948, and appears to have been the first clear-cut ruling on such a law. The Bell Telephone Co. claimed that seizure of its plant was contrary to the constitutional prohibition against taking private property for public use without compensation. The Vice-Chancellor holds that the taking was *pro forma* only, but that such *pro forma* taking was enough, under the statutes, to bring in the compulsory arbitration sections of the law. As to the claims of the unions that those sections imposed involuntary servitude on the employees and that those employees had an inherent right to strike, the declarations of the Vice-Chancellor are of great general interest. He held that individual employees had the right to refuse to work for the Bell Telephone Co., that this right, rather than collective bargaining, was the safeguard against servitude, and that there is no inherent right to strike, beyond the reach of the State, when the strike will cause great injury to the public.

Query: If the seizure of the utility is *pro forma* only and if there is no inherent right to strike when a strike will cause great injury to the public, why is a provision for State seizure necessary and why may not wide-spreading strikes, which cause great injury to the public but which do not involve public utilities, be prohibited?

Note that the Pennsylvania law does not involve State seizure but does provide for compulsory arbitration.

SOME EFFECTS OF THE LABOR LEGISLATION ON UTILITY OPERATIONS

With the exception of the Pennsylvania Public Employees' Strike Act, none of the laws here discussed apply by their terms to utilities operated by governmental bodies. However, it is the firm conviction of the writer that such utilities, as well as all other utilities, are feeling their effects.

The Federal Fair Labor Standards Act covers only some employees of some employers and yet its enactment has set a pattern for wages and payment for overtime which is affecting every employer in the country. In practice it has been found that all employees and all those seeking employment, no matter who the employer may be, know that other employees are compensated with premium wages for time worked in excess of fixed standards of hours. Knowing this, employees not covered by the Act come to expect comparable treatment or some compensatory privileges or recognition. When there is competition by employers for those to staff their enterprises, then employers—including governmental bodies—must bid against those whose employees have the benefits of coverage by the Act. Municipal water plants are affected in their operations, whether their managers realize it or not.

The same is true of the various labor-management relations acts.

A pattern for labor relations has been set by the statutes or, in part, has been recognized and formalized by the statutes, and all utilities and municipalities are affected. The city of New York has experienced one crisis after another in its relations with its employees operating its city-owned and -operated transportation system. The employees, although governmental employees certainly not covered by the old Wagner Act or the newer Taft-Hartley Act, insist on collective bargaining rights and on the right to strike. The issue has not been met head-on but has been avoided by various side-steps, all of which affect the operation of the utility. More and more non-union and city employees, all over the country, are coming to the belief that they have a right to bargain collectively and to have their grievances given fair consideration. This tendency has the inevitable result that all utilities are revising their employee-relations practices and are seeking industrial peace by recognizing the newer patterns in spirit, although very properly refusing to follow the letter of laws, which were not designed to apply to them.

All utilities, no matter by whom owned, serve a public function and the public is affected by their labor relations. Neither management nor the employees should be permitted to forget or to ignore that fact. A shutdown of a water plant threatens the very life of the community and should never be contemplated or tolerated. Neither can the public be asked to tolerate peace at any price. Peace maintained by such a policy would mean an unjustified, constantly advancing cost of service to be borne by the public, if all questions were decided in favor of the workers. If no wage demands were pressed or granted, service would suffer because of justly embittered employees.

What is the answer? How can the relations between public service enterprises and their employees be so organized and conducted that the workers, the enterprise and the public will all be protected, and that essential human rights will not be lost? The answer is hard to find and this writer can only suggest a line of approach to it. The problem results from modern living conditions in highly concentrated urban communities, where the life and welfare of each person and of the group depend on intricate public service enterprises. It is complicated by the fact that the human emotions of management and of labor are the result of many years of clashing interests, misunderstandings, hardships and demands for recognition of individual human dignity.

No quick and easy way to universal peaceful relations is open. No employee and no utility manager will be satisfied with having wages and working conditions imposed on them by the state or other third party. Both employees and management must make sincere efforts to learn how to respect the essential rights of the other without yielding on their own essential rights. Both must learn the art of collective bargaining and must develop, with that art, the determination to reach fair and just agreements, which will recognize the interests of the public.

The new labor legislation affects the operations of all public utilities, by establishing patterns for wages and for collective bargaining and by indicating a firm resolve that there must be no interruption of essential services. We, as operators of water-supply utilities, must learn how to meet our new operating problems.

APPENDIX

(NEW JERSEY)

DISPUTES IN PUBLIC UTILITIES UNDER CHAPTER 38, LAWS OF 1946, AND AMENDMENTS IN CHAPTERS 42 AND 75, LAWS OF 1947*

Since the effective date of the Public Utilities Mediation Act, April 6, 1948, there has been filed with the New Jersey State Board of Mediation a total of 143 notices of dispute (up to August 20, 1948).

Of these disputes, 83 were settled directly between the parties or have not reached a point where Board action is required under the Act. The other 60 have become cases in the Board records.

Of the 60 cases, 35 were settled by the Board through mediation and conciliation, and five were settled by representation elections. Two cases were terminated by mediation and three by conciliation after public hearing panels or arbitration boards were set up.

A total of 13 public hearing panels was named and 10 arbitration panels were designated by the Governor. Four of the arbitration boards were set up under the compulsory arbitration provision of the amended act and six were by stipulation of the parties.

Panel recommendations were accepted by the parties in three cases and five cases were settled by arbitration awards. Twelve cases are in process, with arbitration hearings held in two cases and pending in two others. Four panel hearing boards are being named and three public utility disputes are in the mediation stage.

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*From Records of the New Jersey State Board of Mediation.

UTILITY DISPUTES IN WHICH THE STATE SEIZED THE PLANTS

1. Strike at Public Service Electric & Gas Company's West End and Central plants began on December 24, 1946, and ended December 27, 1946, after State seizure. Dispute was referred to a public hearing panel, which submitted its report to the Governor on January 31, 1947. The Union rejected the recommendations. At a joint conference on February 7, 1947, the issues were resolved. The Union in this case was United Association Journeymen, Plumbers and Seamfitters, Local 274-B.

2. A one-day strike at the Public Service Electric & Gas Company's Paterson plant (June 17-18, 1946) resulted in a return to work after State seizure. The contract issues in the Paterson, Camden and Glassboro plants were referred to a public hearing panel on December 27, 1946. Recommendations of the panel were filed with the Governor on March 11, 1947, and accepted by the corporation and its employees in the affected plants. The Unions involved were Federation of Paterson Gas Workers, Camden Coke and Gas Works Independent Federation, and its Glassboro Local No. 1. Wages were the issue and a $20.00 monthly bonus for six months was agreed to.

3. The strike of the Public Service Electric & Gas Company's Harrison gas plant (December 28, 1946) was submitted to a panel after seizure and return to work, and recommendations of the panel were accepted on January 10, 1947, the filing of a report by the panel being made unnecessary. A $20.00 per month bonus over six months was agreed to. The Union involved was International Chemical Workers Union, Local 269, AFL.

4. New Jersey Bell Telephone Co. strike began April 7, 1947. The plant was seized and the issues in dispute in the matters of the Telephone Workers Union and Telephone Accounting Workers Union were referred to statutory boards of arbitration after a return to work. The parties accepted the awards of these boards.

Wages and other terms of a renewal contract were involved. In the matter of the New Jersey Bell Telephone Co. and the Traffic Telephone Workers' Union, an agreement was reached in direct negotiation.

In the matter of the New Jersey Bell Telephone Co. and the Commercial Telephone Workers, an agreement was reached directly between the parties during the strike.

5. The County Gas Co., Atlantic Highlands, was seized by the State after a strike threat. A statutory panel was appointed and filed its recommendations with the Governor on February 28, 1947. The Company refused to accept the recommendations. An agreement was effected between the parties on March 20, 1947, by mediation. The Union involved was Utility Co-workers Association, Local B-4. Wages and other contract terms were in dispute.

6. The Perth Amboy Gas Light Co. was seized after a strike threat and a statutory Board of Arbitration was appointed by the Governor. An agreement was reached between the parties during the hearing. The Union involved

was International Chemical Workers Union, Local 118, AFL. Wages and other contract terms were in dispute.

7. Public Service Electric & Gas Company's Camden and Glassboro gas plants. After a brief work stoppage the State seized the plant and the workers returned to their jobs. Hearings were held on a wage-reopening question and other issues, and later the same Arbitration Board was called upon to determine wage and other issues on a contract renewal. The Board awarded two cents per hour and the award was taken into court by the Union, but the case was dismissed for late filing. The plants have not been returned to the company as yet. Unions involved were Camden Gas & Coke Works Independent Federation and its Glassboro Local No. 1.

8. The Perth Amboy Gas Light Co. was seized again on August 18, 1948, to end a strike which started on August 16. The strike followed rejection by the Union of a public hearing panel report submitted to the Governor on July 19. A statutory arbitration panel is to be named. The Union involved is International Chemical Workers Union, Local 118, AFL. Wages and other terms of a renewal contract were involved.

Other cases in which statutory boards of arbitration were named without seizure of plants were:

Sussex Telephone Co., by stipulation.
Public Service Coördinated Transport, by stipulation.
County Gas Co., Commercial, by stipulation.
County Gas Co., Distribution, by stipulation.
New Jersey Bell Telephone Co., Plant, by stipulation.
New Jersey Bell Telephone Co., Traffic, by stipulation.

Public hearing panels were named in the following cases in which there was no seizure:

Central Avenue Bus Owners' Association, Jersey City.
North Boulevard Transportation Co. and Hudson County Bus Owners' Association.
Jersey Central Power and Light Co.
County Gas Co., Commercial.
Public Service Electric & Gas Co., Camden Gas & Coke Works.
Public Service Electric & Gas Co., West End and Central Plants.

PRODUCTION OF 84-INCH PRESTRESSED CONCRETE PRESSURE PIPE FOR CITY OF MONTREAL

BY R. M. DOULL*

[Read September 14, 1948.]

THE city of Montreal draws its water supply from the St. Lawrence River through intake pipes running out from the shore about 1,000 ft. The water is taken from this intake and pumped into an aqueduct, through which it flows to the main filtration plant. Under present peak conditions the consumption in the areas served averages about 165 mgd. Not only has it been found that the existing intake is inadequate under present conditions but, due to the increasing rate of shore pollution, it is considered essential to increase the capacity and extend the intake farther into the river, where the effects of this pollution are substantially less.

The New River Intake, as the project has been called, was designed by the city's engineering staff. The plans specify the use of four, 84-in. inside-diameter, concrete, pressure pipe lines to be laid in the river bed, extending out into the river about 2,000 ft. These intake pipes are to be encased in a heavy concrete cover, to protect them from the action of the ice and the swift current which prevails at the chosen location.

Tenders were received for the pipes for this section of the project and a number of alternative designs were considered. After an analysis of the various offers which were received, the city engineers accepted the Preload design. This was considered by some engineers as a daring move to make, as fully Prestressed concrete pipe of this size, without a steel diaphragm, had never been made before on this continent and few related test data were available. Considerable quantities of Prestressed pipe of various sizes had been successfully made in Europe and Australia, notably those built by Freyssinett in France and under the Rocla patents in Australia. In the U. S. A., where Prestressed pipe is now becoming widely used, many miles of smaller sizes, principally with steel diaphragms, have been built. However, the principles of the design now specified had been fully tested in theory and in practice on many large circular structures in Canada, the United States and elsewhere.

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*Manager, The Preload Company of Canada, Ltd., Montreal, Canada.

Each pipe section, weighing approximately 16 tons, is 18 ft. long and 84 in. inside diameter, and the walls are 5½ in. finished thickness (see Fig. 1). In all, 532 pipes are required for the new intake.

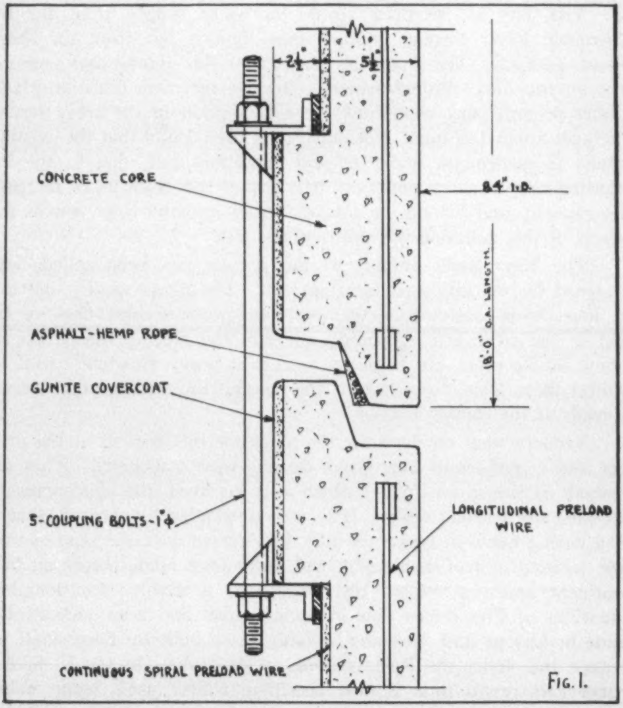
2¼"
5½"
CONCRETE CORE
84" I.D.
18'-0" O.A. LENGTH.
ASPHALT-HEMP ROPE
GUNITE COVERCOAT
LONGITUDINAL PRELOAD WIRE
5-COUPLING BOLTS-1"φ
CONTINUOUS SPIRAL PRELOAD WIRE
FIG. I.

FIG. 1.—SKETCH SHOWING MAIN DIMENSIONS OF PIPE AND JOINT DETAILS.

The most interesting feature of the design was the method of reinforcing, which prestressed the concrete both circumferentially and longitudinally. By use of the Preload design, it is possible to eliminate a substantial tonnage of reinforcing as well as the steel diaphragm which has, in the past, been used in pressure-type concrete pipe. In addition, the sectional area of the pipe wall can be safely reduced. These factors cut down the weight per foot of pipe, making possible, for any given maximum lift, the use of longer pipes with correspondingly less joints than possible with other conventional designs.

The reinforcing was divided into two major systems—longitudinal and circumferential. The longitudinal steel consisted of twelve pairs of wires, each 0.44 in. in diameter, equally spaced around the perimeter and located in the centre of the core wall. The designed initial prestress in this steel was 70,000 psi, which induced 188 psi compression in the concrete. The calculated loss due to elastic deformation, plastic flow and shrinkage amounts to 20,000 psi in the steel and 55 psi in the concrete. Longitudinal bending in the pipe, if supported by a single sling at the mid-point, would reduce these stresses further at the critical section, by 300 psi in the steel and 30 psi in the concrete. The residual stress, after allowing for the above, becomes under the worst conditions 49,700 psi in the steel and 103 psi in the concrete.

The circumferential reinforcing consisted of a continous spiral of Preload wire, wound on the concrete core. This wire, which was developed for prestressed concrete work, is No. 8 gauge and has an ultimate strength in excess of 220,000 psi and a yield point of not less than 175,000 psi. The wire, spaced at 0.31 in. on the flanges and 0.63 in. on the barrel, was applied under an initial stress of 150,000 psi, inducing a compressive stress in the concrete of 725 psi. The hydrostatic test pressure of 50 psi reduces the concrete stress by 412 psi and increases the steel stress by 4,120 psi. Change in stress due to plastic flow, shrinkage and elastic deformation reduces the concrete stress by another 195 psi and reduces the steel stress by 40,000 psi. The net result of the above leaves a residual stress, under test pressure, of 108 psi compression in the concrete and 114,120 psi tension in the steel.

The plant in which the pipe was manufactured was designed to produce an average of three 18-ft. sections per day. In addition to the actual plant building, which had a total floor space of only 7,400 sq. ft., ample space had to be provided for the storage of materials as well as the finished product (see Fig. 2).

A 25-ton travelling derrick, running on standard-gauge tracks, handled all the lifting problems. It charged the steel bins which fed the mixing plant, set and stripped the heavy inner steel forms, lifted the pipe sections on and off the hydraulic test bed and, finally, moved the finished pipe from the cars to the storage area.

The plant contained an 80-hp. steam boiler, which, in addition to supplying live steam for the curing chambers, also furnished heat to the plant itself, as production was carried on during the winter months.

Another multi-service unit was the compressed-air plant. This consisted of a 365-cfm air compressor and receiver, driven by a 75-hp. electric motor. Air from this machine was used for the Gunite work and operated the air winches, vibrators, impact wrenches and miscellaneous pneumatic tools used in almost every phase of the manufacturing process.

The entire plant and storage area was tracked with standard-gauge lines. Turn-tables were used for switching to conserve space. On these rails were mounted 27 special cars. These cars had machined top plates, which served as the form for the inside of the bell end of the pipe and were so constructed that they accurately located the inner steel form. Each pipe section was completely built on one of these cars and remained vertically in place until ready to be transferred to test or storage.

The cars also acted as the anchor for the vertical prestressing. A central hub, bored concentrically with the machined top plate, served to centre the inner form and also to centre the car and pipe for wire winding. The cars were easily moved about the plant from one station to another by means of air winches located at strategic points.

Production started with the setting of the inner form on the car This inner form was a steel cylinder of 84-in. outside diameter, about 18 ft. long (see Fig. 3). A series of levers, carried on a central operating column, was attached to the inner wall of the shell. These levers

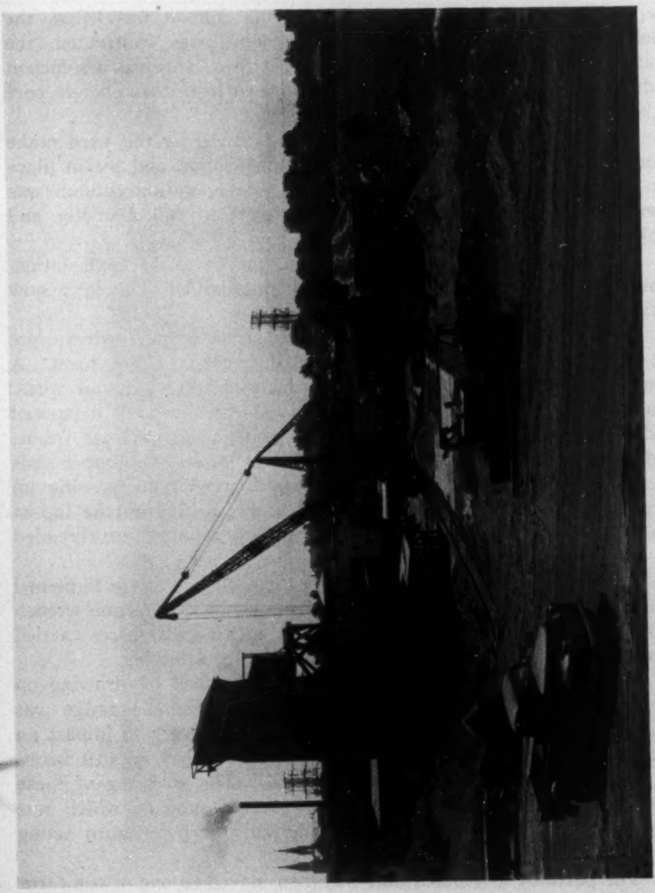

FIG. 2.—GENERAL VIEW OF PIPE PLANT.

were so designed that, when the operating column was lifted, the shell, which had a single longitudinal joint, was contracted, the diameter being reduced by approximately 1½ in. This was a sufficient reduction to permit the form to be withdrawn from the concrete core at a later stage in the operation.

In setting the form on the car, it was lifted by the yard crane from a shackle at the top of the operating column and set in place on the machined top plate of the car. The operating column was then forced downwards, expanding the form to full diameter and locking it in place.

The car, with the form in place, was moved to the next station, where the longitudinal prestressed steel was applied. The form now served a second purpose.

The twelve sets of twin high-tensile-strength steel wires were set at equal intervals around the circumference of the form. A special nut was welded at the end of each of these pairs of wires. The lower end was anchored to the car body by means of a tapered wedge bolt, extending upwards from the underside of the car frame, and threaded to match the special nut on the wires. The upper ends of the wires were similarly secured with tapered bolts passing up through the arms of a heavy spider, or frame, resting on the top of the inner form. The protruding ends of these top bolts were threaded for the fine-thread stressing nuts.

After setting the wires in place, the stressing nuts were tightened up by hand to take up the slack in the connections. A torque wrench was used for the final adjustment, so that each pair of wires carried approximately the same initial tension before prestressing.

The prestressing of the wires was accomplished by drawing up the stressing nuts with a pneumatic wrench. A simple gauge was made to measure the elongation of the wires necessary to impart an equal predetermined unit stress in each of the twelve pairs of wires. An elongation of about ½ in. was required. The stressing of these twelve units developed a total load of 260,000 pounds, which was carried, through the car frame and spider, by the inner form acting as a column.

The partially assembled unit was then moved to one of the three pouring positions. The pouring area had two working floors, one about

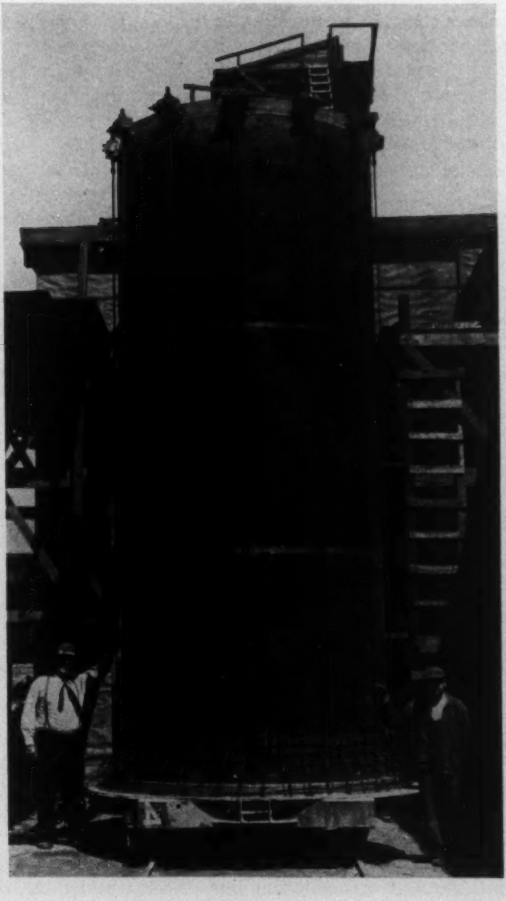

FIG. 3.—INNER STEEL FORM IN PLACE ON CAR WITH LONGITUDINAL PRELOAD WIRES FULLY STRESSED.

nine feet above the car and the other at the top of the pipe (see Fig. 4). The first operation at this location was the erection of the outside steel forms. These forms were made in four rings, each about 4½ft. high. Each ring was made in three segments for ease in handling, erecting and stripping. The lower ring, forming the outside of the bell end of the pipe and part of the barrel, was bolted to the car and the second ring assembled on top. These two rings, forming about half of the core, were then poured from the first level and the second pair of ring forms was erected. The second and final pour was made from the second or top working floor.

The concrete used in the cores was produced under careful control. Storage hoppers, located on the top of the plant and charged by the traveller, equipped with a clamshell, fed the aggregate to the weigh batcher. Cement, sand, two sizes of crushed stone and water were accurately weighed by this plant and fed into a half-yard mixer. The mixer discharged its batch into hoppers, located on each pouring level, through a series of gravity chutes. The concrete thus produced had practically zero slump and averaged well over 4,500 psi compressive strength at 28 days.

The concrete was taken from the hoppers in buggies to the various pouring positions, where it was deposited in the forms and internally vibrated. Two vibrators were used for this purpose with 2¾-in.-diameter vibrating heads. Each lift of about nine feet was poured continously and, as the concrete crew moved from one pipe section to another, the form crew erected each succeeding set of rings. Three pipe cores were poured during each eight-hour shift.

The outer forms were left in place in the pouring position overnight and were stripped the following morning, cleaned, oiled and re-erected. By staggering the hours of work of the various crews each operation was able to run without delay or overlapping.

After the stripping of the outer form, the core, with the inner form and stressing bolts still in place, was moved into the first steam-curing chamber. This chamber, closed at each end with heavy wooden sliding doors, was large enough to store 12 pipe sections at one time on the two lines of track. Heating coils were provided along each wall, with a live-steam line directly under the coils. The live-steam line was provided with pet-cocks to admit steam, which

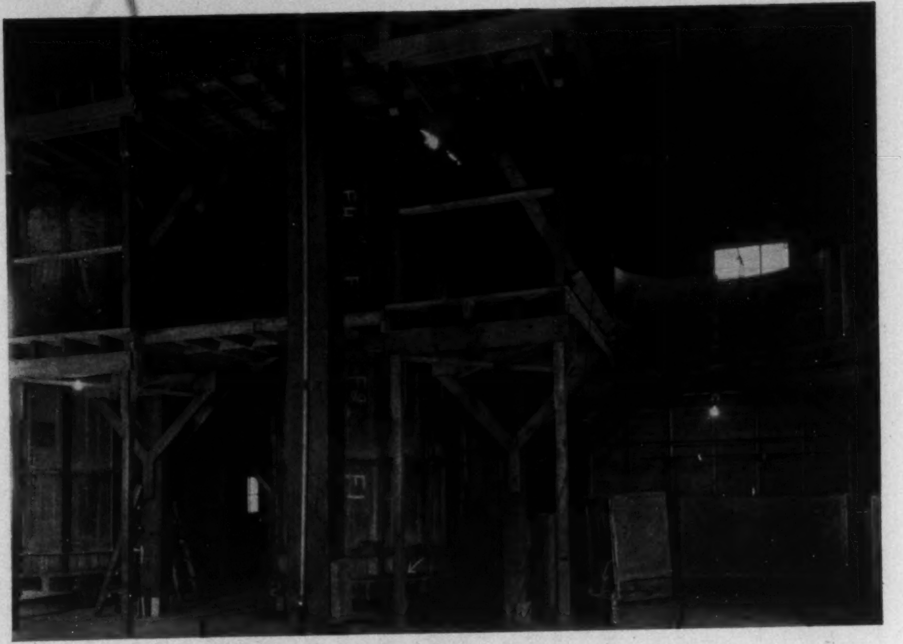

FIG. 4.—THE THREE POURING POSITIONS AND OUTER FORMS IN VARIOUS STAGES OF PRODUCTION.

passed up through the heating coils between the building wall on one side and a baffle plate on the other. The temperature and humidity were thus controlled, during the 72-hour curing period, at 90-100° F. and 100% relative humidity.

After the curing period the cars were moved to the next position. At this point a large roof hatch, directly over the pipe, was opened and the twelve stressing bolts were removed from the top spider, the full longitudinal prestress being thus released to be carried by the concrete core. Tests showed that the concrete had attained at this time a compressive strength in excess of 3,000 psi.

The inner form was then removed by lifting vertically on the eyebolt at the top of the operating mechanism with the derrick. As the operating column was raised, the radial arms contracted, drawing in the shell of the form and reducing the diameter by about 1½ in. At this point the form was clear of the concrete and was lifted out through the hatch. The form was then swung back to the first assembly position and set in place on another car. After cleaning and oiling, it was then ready for another cycle of production.

The core was now ready for circumferential prestressing or wire winding, which was done on a machine designed and built for this specific purpose.

The wire winder consisted of two essential parts—a turntable and a wire-stressing device. The turntable, 10 ft. in diameter, was carried on a series of 12 adjustable rollers. It rotated about a heavy air-operated ram, which could be extended or retracted to engage the central casting on each car, to centre the pipe on the table during the winding operation. The table was driven by a heavy ring gear, which also formed part of the frame of the table itself. This gear was engaged by a pinion, which in turn was driven through reduction gearing by a 25-hp. motor. Variable speed control was provided, to permit adjustment of the peripheral speed of the pipe core between 200 and 300 ft. per min.

No steady bearing was required at the top of the pipe, as the strand load of the wire during winding operations was not sufficient to exert any serious overturning moment.

The stressing device consisted of two main parts—a steel track made of I-beams, rigidly secured at top and bottom and parallel to the axis of the pipe, and a power-operated traveller mounted on these tracks. The Preload wire was mounted on a reel and fed through guide pulleys and rollers to a special wire-drawing die, located in this traveller. The die was of predetermined size so that the pull, or strand load, required to draw the wire through the die was sufficient to create the desired unit stress in the wire itself.

The traveller, carrying the die mechanism, was moved vertically by two endless chains, engaging sprockets mounted on shafts at the top and bottom of the steel track. The bottom sprocket shaft was driven through gears by a positive mechanical drive from the turntable countershaft, the rate of travel, or pitch, being thus synchronized with the turntable. Two speeds were required on the traveller and this was accomplished by a simple gear-shift on the lower sprocket-shaft drive. This lower shaft was also provided with a handwheel and clutch, so that the mechanism could be set manually at any desired position.

The wire was first drawn through the die and attached to the pipe. A special anchor, cast in the lower flange of the pipe core, was used for this purpose. The pipe was then rotated by the turntable and, with the correct gear setting, wire was wound on the lower flange at a pitch of 0.31 in. A print or recess with a steel anchor was cast in the concrete at the point where the diameter of the core changed from flange to barrel. This device led the wire from one diameter to another, permitting continuous winding without the necessity of cutting and tying off at such points. The gears on the traveller were shifted after completing the flange and the winding continued on the barrel at 0.63-in. spacing, until the top flange was reached. Another print in the concrete at this point led the wire to the surface of the top flange, where the pitch was reset to 0.31 in. At the top of the pipe another special anchor was provided, cast in the concrete core, for the purpose of tying off the wire and holding it mechanically until bonded in place by the cover coat.

Since each pipe section required about 1 2/3 coils of wire, or about 500 lb., at least one splice was required on every pipe, as the largest rolls of wire available contained about 300 lb. In order to splice the wire, the stressing was continued until only a few feet of wire remained behind the die, when the top wire was clamped with temporary anchors to the preceding wires. The wire was cut, a new coil threaded through and connected to the wire on the pipe by means of a simple torpedo splice, and the winding continued. The temporary anchors were removed after the completion of the prestressing.

It was, of course, necessary to keep strict control of the unit stress in the wire at all times. This was done in two ways. The actual strand load was checked by means of a calibrated torque wrench, operating through a series of levers connected to the floating die carrier. By operating this wrench while the machine was in operation, the die carrier could be lifted from its support, a fairly accurate measure of the strand load being thus given. By micrometer measurement of the diameter of the wire the unit stress was then easily determined. This approximate check was made on each coil of wire used. In addition, periodic checks were made by measuring the "snap-back" or elongation in the wire, by cutting out a section of wire which was accurately measured before and after cutting.

The wire-wound pipe was then moved to the next position in the production line, where the Gunite cover coat was applied. Gunite was mixed in the proportion of one part cement to four parts sand and to this mixture was added 5% by weight of hydrated lime. A standard cement gun, equipped with a Dual Hydration nozzle, was used to shoot the Gunite in place. The Gunite was shot in one coat to a total thickness of approximately ¾ in. The two end flanges and a short section of the barrel at each flange were finished accurately, steel gauges being used, to permit the application of the steel coupling rings, which will eventually couple the pipes together. The balance of the Gunite surface was screeded only, a rough-textured finish being left to assist in bonding, when the pipes are embedded in concrete in their final location.

After the Gunite had sufficiently set, the pipe was moved into the final curing chamber and cured by the same method followed in the earlier stage for the concrete cores. After this the finished pipe was removed from the plant, lifted from the car by the yard derrick and transferred to the storage yard or the test bed.

Five per cent of the pipes, selected at random by the Engineer, were subjected to hydrostatic pressure tests. For this purpose the pipe was set vertically on a concrete base, centered about a steel cylinder. A heavy, machined steel cover was then placed on top of the pipe and inner cylinder and securely bolted down to steel beams cast in the base. The pipe was gasketed at top and bottom. The space between the pipe and cylinder was then filled with water and the pressure raised to the specified test pressure of 50 psi. This pressure had to be maintained for 15 minutes without any sign of leakage. Not a single pipe showed any sign of failure under this test.

The first pipe produced in the plant was subjected to a series of handling tests, designed to approximate field conditions. During all these tests, check measurements to the nearest 64th of an inch were made to check deflections. First, the pipe was slung on wire slings from the quarter-points, raised and lowered, and then lifted by a single sling from the mid-point. It was then rolled on timber skids through 180 degrees, lifted again and re-measured. After further rotation it was set on a heavy timber bed, resting only on the end flanges with a bearing of about 20 sq. in. at each end. The pipe was then loaded on top with sandbags over its entire length, a load of about 1,000 lb. per lineal foot being applied. Frequent measurements during all these tests showed no deflections within the capacity of the measuring devices.

The final physical test was then applied. The pipe was first balanced on a heavy steel knife-edge. Once again no measurable deflection could be found. Then the pipe was raised 6 in. and allowed to fall freely on the knife edge. The Gunite cover coat was scored but no cracks developed. This operation was repeated from 12 in. and then from 24 in. The first drop was made so that the impact was applied directly over one pair of longitudinal wires, and the second and third were made so that the force was applied between two pairs of longitudinals. The only damage noted was a scoring and crushing of local areas of the Gunite cover coat. The wire was not cut and there was no sign of any failure of bond between the Gunite and the concrete core.

A section of pipe about 4 ft. 7 in. long was then cut out of the centre of the pipe with pneumatic chipping hammers. The steel rods and wire were cut close to the ends of this section. The bond being intact, no loss of stress was expected. This unit was then tested under ASTM C-76-40T specifications for three-edge-bearing crushing-strength tests, with excellent results. The deflections were carefully measured by instrument as the load was built up. The first crack appeared at the crown and invert at a loading of 6,690 lb. per ft. and a deflection of ⅛ in. The loads were gradually built up to 13,500 lb. per ft., at which time the deflection was 1 55/64 in. The measuring device was then removed and the loads were gradually increased to 15,600 lb., at which point the section failed.

The development of this pipe furnished an interesting and startling example of the economies which can be effected by the use of Prestressed concrete. From the cost aspect, the city was able to make a substantial capital saving by adopting this design, as opposed to the conventional type previously used. In these days of shortages of critical materials, the reduction in the requirements of cement and steel was of major importance. The saving of concrete under this design was small, about 10%, but the reduction in steel quantities was impressive. Each Preload pipe section required about 800 lb. of steel, compared with about 3,800 lb. under the conventional design. This represented a total saving in steel of about 1,600,000 lb.

In the near future, it is expected that Prestressed concrete pipe for pressure mains will be developed in Canada covering a wide range of sizes and that all the advantages inherent in the relatively new technique will thus be made available.

DISCUSSION

DONALD C. CALDERWOOD (Nashua, N. H.). On behalf of the Association I want to thank you very much, Mr. Doull, for coming down and giving us this excellent paper.

PERCY R. SHAW (Manchester, N. H.). I should like to ask how thick the Gunite was outside the surface of the steel wires.

R. M. DOULL. It was approximately ¾ in.

ARTHUR L. SHAW (Boston, Mass.). You mentioned the concrete's being based on standard cylinders. Did you happen to make any cores from the pipe itself, to check the relation between standard cylinders and the bearing method in the pipe?

MR. DOULL. No, that was not done. They were of the opinion that, with the new design on which we were working, almost any good concrete was satisfactory for this particular purpose and they were content to accept the hydrostatic test as an indication of what they were going to have in the field. They were not particularly worried about percolation or losses due to such action.

ARTHUR L. SHAW. Did you get any dampness or sweating under the hydrostatic pressure?

MR. DOULL. No, once they got the hydrostatic testing machine fixed up so that it would work properly. We had a lot of trouble located around the gasket, to get a tight joint on the top of the pipe. Once that was accomplished the hydrostatic test was carried on. At first it was carried on for a period of 30 min., but later on they got down to 15. I should say that one pipe was tested to destruction under the pressure test. The pressure was jacked up to 80 lb, which was, according to the design, figured at the point at which it should crack. It actually cracked at 87. The pressure was then released and built up to 50; and the crack completely closed and there was no sign of leakage under the test pressure.

MR. CALDERWOOD. Was each length of pipe tested hydrostatically?

MR. DOULL. One in twenty.

LINN H. ENSLOW (New York, N. Y.). Is this the first prestressed concrete pipe around Montreal?

MR. DOULL. That is the first used in Montreal.

ARTHUR L. SHAW. I have one other question about your process of manufacture, a matter of what you might call safety engineering. I noticed that, when the men were making splices and chopping those grooves, they seemed to be standing fairly close to the pipe, necessarily. I wondered whether any precautions were taken in the event that a pipe might rupture. In that case I presume there would be a terrific impact, which might even kill a man.

MR. DOULL. If you noticed, the man, when he was working, was standing between the joint that he was attempting to make and the stressing mechanism. He would be always to the right of that joint. If the wire broke loose from the clamps that had been put on and the wire snapped back, it would snap away from him. The short length of wire was only a matter of two or three feet and there being intact, no loss of stress was expected. This unit was then tested under ASTM C-76-40T specifications for three-edge-bearing crushing-strength tests, with excellent results. The deflections were carefully measured by instrument as the load was built up. The first crack appeared at the crown and invert at a loading of 6,690 lb. per ft. and a deflection of 1/8 in. The loads were gradually built up to 13,500 lb. per ft., at which time the deflection was 1 55/64 in. The measuring device was then removed and the loads were gradually increased to 15,600 lb., at which point the section failed.

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Stanley M. Dore (Boston, Mass.). Did you have any rejected cores?

Mr. Doull. No. We were very fortunate in not having any rejected cores during the entire manufacturing operation.

INSURANCE PROBLEMS OF WATER-WORKS COMPANIES

BY CHARLES C. GOODRICH*

[*Read September 15, 1948.*]

MY PURPOSE in being here today is to direct your attention to an increasingly serious problem, common to municipal and semi-municipal bodies—that of claims by the public for injury or damages.

Recently, in a western Massachusetts city, a large truck ran into a public bus, damaging the bus severely, causing the driver to be hurled through the windshield and shaking up five elderly ladies, who were passengers in the bus. The insurance adjuster for the trucking company rushed to the scene, escorted the elderly ladies first to a doctor and then to their homes and evidenced complete willingness to pay them and the driver any settlements they demanded. The driver is now suing for a large sum of money, but the five elderly ladies not only signed a release of liability to the trucking company but refused to accept even nominal payments for so doing.

At almost the same time and day in another New England town, a local doctor and his wife invited the neighbors in to dinner. The neighbor's wife tripped over a small footstool in the hallway, skidded on a small oriental rug and ended up in considerable confusion and discomfort at the foot of the hall stairs. The very next day the doctor received an attorney's call, demanding substantial damages for the neighbor's wife.

In these two recent cases, the elderly ladies from Massachusetts represent the old school of thought. The driver and the neighbor's wife represent the modern, claim-conscious feeling that is so prevalent today and is resulting in greatly increased outlays by corporations, municipalities and their insurors to meet a veritable flood of claims for all kinds of things, which formerly were either totally ignored or handled in an informal manner.

Kinds of Claims

Claims of this sort divide roughly into two kinds, those made by employees and those made by members of the public. In the first case the employer has the defenses of a state compensation act and, moreover, he can, through proper safety programs, exercise a good measure of control over the number of such claims to be met.

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*Insurance Adviser, 125 Trumbull St., Hartford, Conn.

Public claims are divided, on the basis largely of court handling and control measures available, into two sorts, those occasioned by a motor vehicle and those occasioned from some other cause. In the first case control measures, including a proper vehicle-maintenance program (such as that freely advertised by General Motors Corp.) and driver safety training, are available and highly developed by many fleet owners.

Non-motor-vehicle public claims, which may range from backing up of sewer or water pipes to falling over sidewalk or road installations, are much more difficult to control through safety-engineering methods and are subject to no case limits, save jury awards in court procedure. It is this last type of claim that I wish to discuss today

One type of public claim that should be feared by water companies, because of its possible huge damages, is the "products claim" for impurities or contamination in the water supply. The chief guards against such claims are, primarily, good engineering practices and numerous sample-test records.

Another type of claim, originating from water-company properties and including risks arising out of the ownership of street water-boxes, water and sewer mains, reservoirs and dams, and buildings including dwelling properties, can be controlled by proper maintenance methods and a regular program of property inspections.

Another and probably the most frequent cause of public claims would be actual construction work, either done directly by the water company or performed under contract. In the first instance, the water company is engaged in what is shown by the records to be a most hazardous undertaking, fraught with possible sources of injury to both employees and the public. In the latter case the water company is up against court decisions, which hold that, where an undertaking is inherently hazardous, an owner may not, by hiring the services of an independent contractor, escape his own liability for injuries to the public.

Insurance Programs

Just like water companies, insurance companies collect sufficient revenue from their customers to pay all incurred claims in addition to their own expenses. Curiously enough, many people, ignorant of the workings of state insurance rating laws, still believe that they can avoid repaying in insurance costs the actual claims incurred in their own class or business. The people of Maine will certainly pay enough for automobile insurance in 1948 to enable the insurance companies to recover the claims incurred in the latest average annual tabulation. The water companies of New England or any other area will be charged a basic rate for all types of liability insurance, based upon the prior five-year record of all water companies in that area.

In order to take the fullest advantage of any special considerations, wherein one water company in any area manages to maintain a better accident record than its neighbors, a plan is available whereby that company can put its smaller claims on a sort of "cost-plus" basis, and this is a good plan and has shown consistent cost savings for the large majority of companies which have used it.

Since, however, such a plan should obviously be limited to small claims only, there is a twin danger, either that the buyer will fail to carry also insurance with high limits against catastrophe claims or that certain risks will be omitted from the "cost-plus" plan altogether. To a corporation insurance limits of $1,000 to $5,000 are really not insurance at all. Only a limit which would reach the point of serious financial embarrassment to the corporation fulfills the basic purpose of insurance protection. Such a limit, set for collapse of a dam, a major sewer explosion or a large water-impurity claim, would be more nearly $100,000 for one claimant and $1,000,000 aggregate, and such insurance can and should be bought separately from the "cost-plus" program for minor claims and on a flat-rate basis. Furthermore, since each liability risk insured against is usually a remote hazard, but one which could result in very large claims, any attempt to select among the field is most imprudent. Full-coverage policies should be obtained for high limits to include all insurance risks.

The result of this recommended program is to make sure that the water company has adequate insurance against catastrophe claims and to relegate the smaller claims to a semi-self-insured basis, the services of trained insurance adjusters being utilized at the lowest available cost basis.

Adjustment Procedure

That the services of insurance adjusters, particularly those of the large stock companies, are valuable is proven today by the flood demand for their services by the larger corporations, which demand has now strained the facilities of many of the better known insurance companies to the point where a sort of rationing program is becoming evident in selection of customers.

The three chief reasons for the demand for insurance adjusters are that:

1. Their services can be obtained at less cost than that for instituting a complete claims department.
2. Use of such an outside service seems to develop better relations, both with employees and with the public.
3. Their training produces better results in claim handling.

There have been two main methods of insurance-claim procedure—(1) the method of rushing after a claimant with a $10 bill, to try and effect a quick and economical settlement, and (2) that of resisting by court action every claim, in an endeavor to establish a reputation for severity which will discourage claimants.

It is found on analysis that these two systems, over a period of years, produce almost identical results and today there is a trend towards a mixed system, wherein the adjuster first tries for an amicable settlement and, failing to get it, reverts to the stiffest possible court resistance.

Safety-Engineering Procedures to Avoid Claims

Although the constant training of adjusters by the larger insurance companies does show measurable results in claim costs, the main reliance of the insurance buyer should be in actual prevention of accidents altogether. As regards public claims against water companies, not motor-vehicle claims, certain defense methods are available, although current safety-engineering programs are developed more highly in the fields of employee and motor-vehicle accidents.

Assignment of Responsibility to Contractors

When construction work is contracted out, a responsible contractor should be chosen, who has the experience and the facilities to complete the job efficiently. The contract should call for placement of liability insurance at appropriately high limits, depending on the nature of the work and the exposure, covering both personal injury and damage to property, in an insurance company acceptable to the principal. The contractor should be held responsible for any work being subcontracted.

A standard "hold harmless" clause should constitute a part of every contract. The contract may also well contain a clause for the provision of separate protection to the public and safe execution of the work in a manner acceptable to the principal, and the principal should make certain that the contractor lives up to the requirements. By following such a program consistently, construction work which might otherwise give rise to many accidents can be executed safely and to the credit of the principal. Furthermore, the principal will be relieved of liability and the consequential various public reactions, if an accident does arise.

Safety Engineering to Prevent Accidents

The elimination of all possible hazards in conjunction with waterworks operations should be the objective of the management; first, because an accident is far less likely if all accident-producing conditions have been eliminated, and secondly, because, if an accident does occur, due to no fault of the water company, there will then be no negligence on the part of the water company which can be advanced as a basis for a high liability award.

Safety engineering is based on the fundamental irrefutable premises that accident-producing conditions can be located through a proper inspection program and that these exposures can be eliminated through intelligent engineering. This applies to accidents to the public, including motor-vehicle accidents, and accidents to employees.

It is not my purpose at this time to outline a full accident-prevention program to you, because such a program should be tailored to your specific problems, but a few fundamentals should certainly receive your attention:

1. Establishment of clear-cut responsibility for all safety work throughout the organization, which will be fully understood by all persons.
2. Proper guards about all construction or maintenance work. This will require the establishment of certain definite standards, provision of suitable signs and protective equipment, and supervision of the job to see that the protection is kept in place at all times, particularly at night.
3. An effective maintenance and inspection program on all properties, so that defective conditions will be detected promptly and corrected at the earliest possible date.
4. Careful check to eliminate "back-water" connections, "cross" connections and any similar conditions, which may lead to pollution of a water system which can result in illness of many persons.

In addition to a formal inspection program, it is sometimes very helpful to sponsor a system whereby all employees have a sense of responsibility for locating dangerous conditions, with a suitable reward (if only commendation) for their efforts. If each employee felt that it was his duty to look for and report all accident-breeding conditions, the corporation would have an opportunity to correct the condition before an accident occurred. Otherwise, the first notice that the water company receives of a bad condition, such as a water box, comes when advice is received from an attorney, whose case is all prepared.

No safety program is successful unless it is backed by top management with sufficient interest so that every employee knows that management wants and insists on all operations, being conducted in a safe manner. If a water company is to obtain a safety record that is better than average, then the top executives of that company must be sold on the value and beneficial results obtained from an effective safety program. Such executives must participate to the extent that they let all employees know that safe operation must be a part of the everyday activities of each and every employee.

These executives should follow periodically the safety records of various supervisors and discuss with those supervisors having poor accident records ways and means of improving the accident experience. This interest and follow-up on the part of management is absolutely necessary, if a continued good record is to be maintained.

Discussion

Donald C. Calderwood (Nashua, N. H.). We had an interesting experience at home this past year. We were making an excavation for a new service on the main street and ran into a little tough luck, so that we had to leave the hole open overnight. It was on Route 3, which goes through the heart of Nashua, at the southern end of the town. Three youngsters had been to Lowell, the city next south of us, and, getting back around 1:45 a.m., for some reason or other they did not see the warning lights and their car struck the excavated material head-on. Luckily it was sand. They entirely hurdled the open excavation and a pile of paving blocks and finally wound up facing the curb, fairly smashed up. The boys that were in the car received a broken nose and a few minor injuries—not too bad—but they thought they had a good case and they took it to court. Luckily, the police cruising car had gone by the hole not five minutes before the accident happened. We were also fortunate in having two workmen "Johnny-on-the-spot," who said the hole was properly protected and lighted, and we were let off without having to pay any of the claims. As in many cases of that type, I believe that they had had a little liquid refreshment and, while it never came out in court, some of these things were left to the jury's imagination.

Have you had any experiences that you want to relate, Mr. Fuller?

Harry U. Fuller (Portland, Me.). I was thinking about asking Mr. Goodrich one question. Is it practical and possible for the water utility to pass on to a contractor all of the liability? If a water utility employs a contractor to dig a trench in a street, lay the pipe and back-fill the trench, can it protect itself by some form of contract so that the contractor carries all the liability?

Charles C. Goodrich. The utility can have the contractor assume all the risk except intervention in the work. Where the utility, through an officer in an official capacity, interferes with the contractor or unduly directs him, they cannot force that risk on him. But there are two things they can do. They can ask him to be responsible for all his own actions or those of anybody working under him, and they can ask him to be responsible for any case where he is jointly liable with the utility. In either case, however, reliance should not be placed solely on the surety bond. There should be a contract defining that liability assumption and it should be specifically insured. The utility should get a copy of the insurance policy with the exact wording that the contractor agreed to, together with the insurance rate, and then there can be no misunderstanding.

Mr. Calderwood. I wonder if Mr. Dore has had any experience in construction around Boston that would bear repeating for the group.

Stanley M. Dore (Boston, Mass.). We are building a tunnel under Boston and of course we get a large number of claims from residents in the populated district under which the tunnel is driven. But our contracts all provide that the contractor is to carry liability insurance. The contractor is not doing a PWA job. The federal government required $50,000 of liability insurance to be written into the contract. I think that is in line with what the speaker suggests in calling in a third party, the insurance company, to take care of the carrying of these claims.

In addition, in our construction program we require the contractor to furnish a signed release of all claims, before he is paid his final estimate. But most contractors turn this liability over to an insurance company. As the speaker has pointed out, the policy written by the insurance company must be such that it covers a wide enough range for all the claims.

I don't know whether the speaker has anything to recommend regarding the manner in which the various companies of this association might handle the situation, in order to alleviate a large number of claims that might be forced against the companies in the doing of work. Of course some of them are valid claims, but a large number of them, in the opinion of those doing construction, are invalid. I wonder if he has anything to suggest about a program which might be initiated to cut down the number of those claims.

Mr. Goodrich. The best way to eliminate claims is through proper safety-engineering prevention. If they can't be eliminated, the best way to handle them is through expert claim research, which has to be much more highly developed than it is today, both professionally and otherwise, in order to meet the problem.

There is one final way, which is highly controversial. It has been discussed by state legislatures for 25 years without a decision and it may come up again, if this burden becomes too intense. I mentioned early in my speech that employee claims are more easily handled, because the employer has the safety of the state compensation act, which limits the amount. It has been felt by a great many people that it is an odd thing that an employee of a water company can fall down and get a stated amount of his claim in damages, whereas a member of the public can fall down in exactly the same place and in exactly the same way and get anything the jury will give him, even though he may have the same earning power as the employee of the water company. I understand that Mr. Ballantine, who, I believe, was a New York State legislator, drew a law in which damages for motor-vehicle claims were limited by law, somewhat similar to compensation claims, and the report of the Ballantine Committee was discussed for 15 years and then buried. Possibly it could be revived with changes. To revive it would require a strong public opinion. It would require that cities, corporations and utilities would decide that they wanted relief from unlimited third-party claims.

I believe it to be the case that the amount of money paid out in these claims falls very heavily in the few high-judgment cases. In other words, if, let us say, in Boston the insurance company pays a million dollars in accident claims, a very undue proportion of that sum lies in the high-judgment bracket, so that a few people are getting very huge awards and everybody is being assessed to reimburse the insurance companies for those awards. Now, in opposition, an attorney will state right off that it is wrong to deprive a man of this common-law right—that if an individual, from his position in the community, is able to collect $100,000, why shouldn't he be allowed to do it? He could not do it under a state compensation act and individuals are insured under those acts. So that I think there is merit in the approach of claim limitation. Many states have now a death-claim limitation. If you run over a man and kill him, you will probably have to pay $20,000 in a New England state, but if you do not quite kill him, you may have to pay $75,000. The thought would be that perhaps we could enlarge on the damages, so that it will be so much for an arm and so much for a leg, and work that into a law.

A second approach, which is equally controversial, I think, is the extent of governmental immunity. Water companies and other municipal departments have an extension of government immunity on a number of different grounds. One is that they have the defense of no notification of claims. The city of New York has a right to call in a claimant and examine him orally and physically with their own doctors, and the city cannot be sued unless a claimant gives notice, within 60 days of the happening, what he intends to sue for. Things like that can be enlarged upon through legislative action, and that applies not only to water companies but to all the electric light companies. The cities have a feeling that they would like to get together and advance that cause. But I feel, looking at the trend, with the liability judgments going up at an accelerated rate, that the burden on the corporations will shortly be so heavy that they will begin looking about for methods of reducing the accident rate, and I believe that some of the suggestions offer a fruitful line of approach. It would probably be wise for them to get together and hit on one line of approach and try to advance it through to law. That would be my suggestion.

MR. DORE. The speaker has confined himself mostly to liability. A number of claims are based on convenience and nerves. I wonder what the attitude of the insurance company is in handling claims for compensation for convenience and nerves.

MR. GOODRICH. Well, there are two ways to handle claims in general. There are two very large insurance companies in Hartford. One has rushed out with a $10 bill to try to make a quick settlement; the other has based action more on trying to establish a record for severity in disputing claims. After 15 years of compiling records they find their records are the same. Today they are tending to a mixed settlement, where the adjuster offers a small amount quickly and often saves the claim from going to court. If it is a serious case—a case of indirect damages—that is a question of getting proper medical testimony. Unfortunately it seems to be possible to get any amount of testimony on both sides of a case. At least as far as employees are concerned, the final arbiter is the doctor. The state compensation referees rely on medical testimony. In public claims the lawyers have the final word.

ARTHUR L. SHAW (Boston, Mass.). In answering Mr. Fuller's question, Mr. Goodrich pointed out that it was necessary to cover by contract any transfer of liability from an owner to a contractor. He undoubtedly meant that quite broadly and intended to convey the thought that that contract must be very carefully drawn. I mention that because it has recently come to our attention that, if you merely say in your contract that the contractor must provide public liability insurance and you accept the standard form of policy, you may find that the owner or utility is not adequately covered. For example, as I understand it, the normal public liability policy does not cover damage to underground utilities, telephone cables or gas mains, if you are laying water pipe, nor does it cover a case where a building may slide into your excavation. If you want to be fully covered for matters of that kind, you must see in your contract, or in accepting your insurance certificate, that all of those contingencies are covered, as well as the ordinary one of a man or a vehicle falling into an excavation.

There is one other thing which may not be covered, and that is the case where an employee of the contractor hops into his own car, runs down to a hardware store to get a bolt for the bulldozer and gets into an accident. That may or may not be covered. Similarly, the use of hired trucks by the contractor may or may not be covered. There are many such things which must be covered in considerable detail in the contract between the owner and the contractor, if the owner wishes fully to transfer the responsibility to the contractor.

MR. CALDERWOOD. Thank you very much. Has Mr. Goodrich any further comments to make on those statements?

MR. GOODRICH. That is a very well-taken point. The drawing of the contract is usually done by the utility's attorney. Wording wherein the contractor assumes the liability is the whole thing. That has to be done right. There are "hold harmless" clauses, used by very large national corporations, which could be copied, but it is better to have one drawn by the utility's own attorney. It is very easy. You put the exact wording of the construction contract into the insurance paper and recite down at the bottom that the insurance company insures the liability assumed by the contractor in this contract, and name it, and then there can be no question whatsoever. It is called the contractual liability-assumption clause. If that is done, there can never arise any question of coverage, because the exact wording of the construction contract is insured. Any attempt to shorten it or extend it leads to difficulty.

MR. CALDERWOOD. On behalf of the Association, I want to thank Mr. Goodrich for his very informative paper and I know that, as it is printed in the JOURNAL, along with the discussion of it, a lot of good will be obtained by the water-works industry. As Mr. Goodrich says, the public is becoming more and more insurance-conscious.

WATERSHED INSPECTIONS IN CONNECTICUT, INCLUDING PROBLEMS OF HOUSING DEVELOPMENTS

BY FREDERICK O. A. ALMQUIST*

[Read September 15, 1948.]

AUTHORITY for the general sanitary supervision of public water supplies in Connecticut is given to the State Department of Health under Section 2528 as amended by Section 926e, Section 2529 as amended by Section 997c, and Section 2530 of the General Statutes, and this work is carried on in coöperation with local utilities, which furnish the more detailed supervision. One of the most important phases of the work in protecting these supplies is the inspection of watersheds or drainage areas above reservoirs or water-works intakes. Some of the problems and experiences will be discussed and some laws, regulations and suggested forms or ordinances will be found in an appendix to this paper. (See Appendix I for the above laws.)

GENERAL INFORMATION

In Connecticut an estimated population of 1,721,000 persons, or approximately 96% of the 1947 population of the state, is furnished with water from a public water supply. There are 112 of these supplies, exclusive of small semi-public supplies or summer-colony supplies, furnishing water to 205 communities. The source of water for 66 of these systems is lakes, ponds or streams, while 33 obtain water from ground-water sources and 13 from both ground water and surface water. At least one annual inspection by the State Department of Health is made of each system, while several inspections yearly are made of filtration plants, chlorination plants and other pertinent facilities. The watersheds are inspected approximately annually and follow-up inspections are made more frequently.

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WATERSHED INSPECTIONS DESIRABLE

Since chlorination of public water supplies is still the most important means of protection in Connecticut in so far as treatment is concerned, the time spent on detailed inspection of watersheds is fully justified. Where more adequate treatment is provided, watershed inspection may be of somewhat less importance, although in Connecticut the watershed regulations hold, regardless of the type of treatment, and such watershed protection is on the safe side. Many epidemics of water-borne diseases have been traced in the past to careless contamination, of a human nature, of surface waters on public water-supply drainage areas on systems without adequate treatment. The U. S. Public Health Service at the Cincinnati Experiment Station some years ago concluded that the more adequate the treatment, the higher could be the coliform index or the greater the pollution of the raw water from the bacteriological standpoint. It follows that a greater factor of safety is afforded with a reduced bacterial load in the untreated water. While the maximum coliform index recommended by the U. S. Public Health Service for untreated water, where both chlorination and filtration are provided, is 20,000 per 100 ml, the maximum recommended for untreated water where chlorination only is provided is 5,000 per 100 ml. It seems desirable, therefore, that human sewage should be eliminated when feasible from the source of water supply before treatment, not only from the aesthetic standpoint but also from the standpoint of safety. This is especially true where only one type of treatment is provided, such as chlorination, and an interruption in treatment is likely to occur sooner or later in spite of every precaution, including duplicate equipment.

WATERSHED SANITATION

Regulation 112 of the state sanitary code (see Appendix II) governs the watershed inspections. In company with a representative of the local utility, a State Health Department engineer visits all locations on tributary streams or brooks where a violation of this regulation might occur. This means, roughly, that a visit is made to all houses, barns, pig pens, etc., within 250 ft of a stream. Where conditions are found which may be potentially dangerous to a water supply, an attempt is made to have the owner make the corrections, the personal benefits from the corrections being pointed out to him. If the unsatisfactory condition existed before the brook or stream was developed as a public water supply, it has been the policy of most Connecticut water utilities to correct conditions at the expense of the utility. In some cases where an objectionable condition has developed after the use of the water was authorized for public supply purposes, the local utility has either corrected the condition at its own expense or provided assistance. While not necessary under the law, the local utility has coöperated in this manner, in order to obtain the correction quickly and in a proper manner and to maintain the good will of the resident. The latter point cannot be overemphasized. Persons residing on a watershed and having a friendly feeling toward a water utility can be of considerable help in maintaining good sanitary conditions.

When particularly vexatious conditions occur, where the property owner will not coöperate, there are several ways whereby conditions may be corrected. Each town in Connecticut has a health officer and violations of the sanitary code regulations may be corrected by the issuance of orders by the local health officer to comply with sections of the code. Authorization is given the public health council to enact sanitary code regulations and these regulations, therefore, can be enforced and have been held valid in court. In some instances, where the local health officer does not consider that the pollution of a brook supplying water to a town miles away is of sufficient interest to him to serve a corrective order, the Commissioner of Health of the State of Connecticut may, under authority of Section 2530 of the General Statutes, summon the owner of the property to appear in his office for a hearing, after which an order may be issued by him to correct the condition. The third means of obtaining relief is for the local utility to seek a temporary injunction through the superior court, restraining the offender from pollution of the stream. This can be done under Section 2539, amended by Section 930e, of the General Statutes and appears to be a more rapid way of obtaining corrective measures than the other two, because injunction proceedings are placed on a priority list in superior court and appeals in lower courts may delay matters where orders are issued. (See Appendix III.)

When and how to make watershed inspections vary considerably with conditions. A watershed inspector must be versatile and must especially be a diplomat. Meeting all types of people, he must be careful of his language, "sizing up" the individual, leading where it appears desirable and being firm where necessary. Because of the advantage of maintaining good will of watershed inhabitants, the inspector should strive for an amicable correction of an objectionable condition. The writer has had many pleasant visits on watershed inspections but can also recall a few persons who could be called names that would not look elegant in print in this journal. Yet one must treat each one impartially and maintain an even temper.

It is necessary to know in detail the watershed being investigated and the boundaries. The recent U. S. Geological Survey maps—scale, two inches equal one mile—are excellent and an improvement over the older U. S. Geological Survey maps with a scale of one inch to one mile. The U. S. Army Engineers contour maps are nearly the same scale as the new U. S. Geological Survey maps and, although not so accurate, are also very useful. Some water utilities have had aerial maps made of their watersheds.

Frederick Silliman, sanitary engineer of the Bridgeport Hydraulic Co., has correlated the aerial maps with the ground maps, traced each boundary line of the water-company holdings and followed every stream to the source. A card index is maintained by Mr. Silliman, showing the individual properties inspected, together with a description of the sewage-disposal system and location measurements to the different parts of the system. A measurement is also kept of the nearest distance to a stream. A notation is made of the date of each inspection and the conditions found. Other companies maintain books, instead of cards, in which this information is kept. This is the case at Greenwich and Stamford, the latter using numbers for the locations, with odd numbers on the left side of the highway and even numbers on the right. It is also possible to use pins of different colors on wall maps in the office, to denote different degrees of sanitary conditions.

These records would all be useless, however, if not kept up to date. This means frequent inspections, and the larger water utilities maintain full-time men for this purpose and a portion of the watershed is visited daily. Smaller companies, which cannot afford full-time men for this purpose, should visit all locations at least three or four times a year. The ease of getting into the country with automobiles and existing good roads, with the possible exception of the war years when gasoline was difficult to obtain, has caused houses to be constructed in out-of-the-way places and frequently close to streams. It is, therefore, desirable to "catch" a dwelling before construction is actually under way, so that the location of the sewage-disposal system can be placed so as to comply with watershed regulations.

The interpretation of the danger at a particular location or, in some cases, as to whether sanitary regulations are actually being violated is sometimes difficult and much is sometimes left to the judgment of the inspector. Conditions may look different at different times of the year. The best time to make a watershed inspection is during, or immediately after, a prolonged rain, but this is not always possible. A violation of the regulations could easily exist after a rainfall or during a rainy season, whereas this same condition, if the inspection were made during a dry season, could very easily be given a good rating at the time, although dangerous to the water supply at other times.

Any steps taken that might lead to court action should be taken only when a violation exists. A watershed violator should be taken into court only as a last resort and then, in most cases, only when a favorable court decision is a certainty. An unfavorable court verdict becomes known rapidly over a watershed, resulting in difficulty sometimes to a watershed inspector. Hence, a favorable decision is highly desirable.

Engineers, making watershed inspections in Connecticut, carry copies of the laws and regulations and bulletins on sewage disposal, and are ready to answer any pertinent questions. They also carry a can of 70% available-chlorine powder and, if fecal matter is found where it may wash into a stream, chlorine powder is spread on the material with a request for immediate burial. There appears to be a psychological effect upon the offender in the use of the chlorine compound, in addition to affording some protection.

While not required by law to provide advice as to the design of sewage-disposal systems when calling attention to a watershed violation, engineers do try to aid in so far as possible. A sewage-disposal bulletin is available, which shows accepted designs of different types of systems, such as the common privy, cesspool, septic tank and tile fields. There is also a table, which can be used for soil tests, to determine the amount of seepage area necessary in different types of soil. When very troublesome conditions are encountered, the employment of the services of an engineer experienced in design of small sewage-disposal systems is recommended.

There are times when proper disposal of sewage from a property is almost impossible. The owner would either have to transport the sewage away or vacate the property under these conditions, and obviously it would be to the advantage of the water utility to purchase the property, to eliminate any chronically objectionable conditions.

So far as animal contamination is concerned, since this type of contamination is generally not considered to be of great sanitary significance, there is no law in Connecticut concerning such contamination, except where accumulations of manure are concerned. (See Appendix II.) However, when there is a considerable amount of pasturage in low areas, it is frequently recommended that the utility involved purchase the property. The pasturage of cows close to streams on watersheds is objectionable, mostly from the aesthetic standpoint, although it may introduce a heavy load of bacteria of the coliform type, which one does not like to find in a stream tributary to a public water supply.

There are one or two other situations encountered in watershed inspections. One of these is the washing of clothes, animals or other articles in tributary streams. This is prohibited by Section 2543, amended by Section 520g, under penalty of $100.00 fine or imprisonment for not more than 30 days, or both. Another is the deposition of animals in reservoirs or tributary streams. This is covered by Regulation 106 (b) of the Connecticut State Sanitary Code, which requires that the carcass of a dead animal be buried within 24 hours of death.

HOUSING-DEVELOPMENT PROBLEMS

So far the discussion has been entirely of single locations on watersheds. In recent years difficulty has been encountered because of groups of houses or developments concentrated in relatively small areas on a watershed. There have been roughly three classes: government-owned housing projects, the housing projects financed by private funds, wherein a large group of small houses is built at one time, and the developments financed by private capital, with one house built at a time on a speculation basis. The latter two might be approved for F.H.A. mortgages, which require certain minimum standards of construction. Developments comprising a large number of houses on a watershed could very well be a source of considerable concern to a water utility. In Connecticut there are several means of taking care of these situations.

First, the general statutes of Connecticut, Section 544 and Section 135g (see Appendix IV), provide for the establishment of districts—that is, a group of citizens may petition for the formation of a district for various purposes, such as the collection and disposal of sewage. A common, privately constructed, sewage-disposal system for a group of houses on a watershed, in general, is undesirable, because of divided responsibility. With responsibility fixed on the officials of a district, the objection may not be so great. Where a district is formed, it is possible for the officials to arrange for collection of the sewage and provide for the pumping of the sewage off the watershed to an existing or new sewerage system. This has been done on at least two of our watersheds and has solved the problem very satisfactorily.

A second means of overcoming possible objectionable conditions from disposal of sewage, where soil-seepage conditions are poor, is the establishment of a local ordinance which prohibits the construction of sewage-disposal systems, unless approved by a designated town official. The enabling act is Section 2657 of the General Statutes. (See Appendix V for the statute, together with a recommended ordinance.) This section applies to all locations in a town, whether on a watershed or not, and is considered by the State Department of Health to be a desirable local ordinance to enact.

A word of warning might not be remiss at this time. In some communities two permits are required, one from the building department, before a house can be constructed, and the other from the health officer or sanitary inspector, after approval of plans for the sewage-disposal system. Unless there is close coöperation between the building inspector and the sanitary inspector, a person taking out a building permit might unwittingly be under the impression that he can begin construction of the house, not realizing the need for approval of the sewage-disposal system. It would be well to have this requirement noted on the building application or a printed notation attached to the building permit. Suggested forms for both application and permit are shown in Appendices VI and VIA. A still better arrangement would be to withhold the building permit until *after* the approval of the sewage-disposal system, following investigation of the site. This investigation should be made before any construction is started and any construction under way before a construction permit is obtained is a violation of the law.

Wide-awake watershed inspectors can obtain helpful information by watching local papers for notices of issuances of building permits or changes in title to real estate. They can also, through coöperation of local health officers or building inspectors, obtain information as to recent applications or approvals for sewage-disposal systems.

Another means, perhaps supplementary to the other two, is to make sure that persons cannot build on a lot too small to permit proper disposal of sewage on the property. This means the promotion of zoning and zoning ordinances. The writer believes that zoning should extend to all communities, rural as well as urban. Even in rural communities, property is protected by the proper type of ordinances. But for zoning ordinances in one town on the New Haven watershed, where large lots are required, a considerable amount of trouble would have resulted. The soil is generally poor for seepage purposes. M. S. Wellington, sanitary engineer of the New Haven Water Co., in coöperation with a representative of the State Department of Health and the local health officer, was instrumental in the establishment of the ordinance requiring large lots in the town. This afforded ample area for sub-surface systems. Even where the requirements are ample, local utilities must be constantly on the alert to assure that certain groups do not cause changes which lower requirements.

Also helpful, so far as watershed protection is concerned, in Connecticut is the fact that the 1947 Connecticut General Assembly passed an act permitting towns and cities to create by ordinance a planning commission, which may regulate subdivisions and require approval by the commission for plans of a subdivision. The important part, so far as water utilities are concerned, is that regulations shall provide that the land to be subdivided shall be of such character that it can be used for building purposes without endangering health and that proper provisions shall be made for water, drainage and sewerage, among other things.

There is a federal housing project just above a well field in one town. It has a central sewage-disposal system with sub-surface disposal of the settled sewage. While under the direction of the manager of the project, there is not likely to be much trouble but, if the houses are sold to individuals, some arrangement will have to be made to fix the responsibility for the continued operation of the system in a satisfactory manner.

Another group of dwellings that can be potentially dangerous to a water supply, if poorly located, is a trailer camp. The difficulty of obtaining proper housing has recently caused a large increase in the number of these camps in Connecticut. While sanitary code regulations Nos. 109 and 126 govern the sanitation of trailer camps, the State Health Department has recommended that towns adopt a trailer-camp ordinance. The ordinance requires approval of the State Department of Health for disposal of sewage. Trailer camps in Connecticut are inspected regularly by a representative of the State Health Department in coöperation with local health officers.

CONCLUSIONS

1. In Connecticut, watershed sanitation is considered to be in the nature of first-line defense against water-borne disease. This is especially true in case of breakdown of equipment or facilities in treatment plants.

2. Adequate laws and regulations should be available to aid a watershed inspector in his work.

3. Care should be exercised in the selection of a watershed inspector, to assure that he is not only intelligent and trained in the work, but capable of meeting persons well and exercising tact and good judgment.

4. Where housing developments are encountered, efforts should

be made to secure local ordinances that will protect the community and, in the process of protecting the community, will protect public water supplies. In Connecticut, the State Department of Health is constantly striving, in coöperation with local officials, to have local ordinances enacted that will insure satisfactory disposal of sewage and other wastes.

5. A safe water supply is one of the most important commodities in a community and it is of utmost importance from the health standpoint that the safety be uninterrupted. It is believed that watershed inspections of the proper kind play an important role in the maintenance of the safety of a supply.

APPENDIX I

Water and Ice Supplies—Jurisdiction of State Department of Health—Qualifications of Water Treatment Plant Operators

Sec. 2528 (amended by Sec. 926e). The state department of health shall have jurisdiction over all matters concerning the purity of any source of water or ice supply used by any municipality, public institution or water or ice company for obtaining water or ice. The qualifications of the operators of plants for the treatment of water furnished or intended to be furnished to any such water supply shall be subject to the approval of said department. The term "source of water or ice supply" shall include all springs, streams, water courses, brooks, rivers, lakes, ponds, wells or underground waters from which water or ice is taken, and all springs, streams, water courses, brooks, rivers, lakes, ponds, wells or underground waters tributary thereto and all lands drained thereby.

Statement of Water Supply Approvals—Petition to General Assembly

Sec. 2529 (amended by Sec. 997c). Each person, firm or corporation supplying water to the public shall, on request, furnish the state department of health with all reasonable information regarding its water works and the source from which its supply of water is derived. No system of water supply owned or used by such municipal or private corporation or individual shall be constructed until the plans therefor shall have been submitted to and approved by said department. The state department of health shall consult with and advise any municipality or private corporation or individual having or desiring to have any system of public water supply as to proposed sources of water supply and methods of assuring their purity. Each petition to the general assembly for authority to develop or introduce any system of public water supply shall be accompanied by a copy of the recommendation and advice of said department thereon.

Interstate Waters Used for Drinking Water Supply

Sec. 927e. For the purpose of protecting the purity of interstate waters used or intended for use by any municipality, public institution or water company of this or of any adjoining state or states, as sources of drinking water supply, and with a view to reciprocal action by adjoining states for the benefit of this state, the state department of health is authorized, at the request of the department of health, or the official body having similar powers and duties, of an adjoining state, to provide in the sanitary code rules and regulations for the protection of the purity of the waters of any lakes, ponds, streams and reservoirs, within any specified drainage area in this state, tributary to any such drinking water supply of an adjoining state.

Investigation of Water Supply

Sec. 2530. The state department of health may, and upon complaint shall, investigate any system of water supply or source of water or ice supply from which water or ice used by the public is obtained, and, if it shall find any pollution or threatened pollution which in its judgment is prejudicial to public health, it shall notify the owner of such system of water or ice supply, or the person or corporation causing or permitting such pollution or threatened pollution, of its findings and after hearing shall make such orders as it shall deem necessary to protect such water or ice supply and render such water or ice safe for domestic use.

Appendix II

CONNECTICUT STATE DEPARTMENT OF HEALTH

Chapter II.

RULES AND REGULATIONS GOVERNING SANITATION OF WATERSHEDS

Reg. 112. (a) No cesspool, privy or other place for the deposit or storage of human excrement shall be located within 50 feet of the high water mark of any reservoir, stream, brook, or watercourse, flowing into any reservoir used for drinking purposes.

(b) No cesspool, privy or other place for the deposit or storage of human excrement shall be located within 250 feet of the high water mark of any watercourse or reservoir as above mentioned unless such receptacle is so constructed that no portion of the contents can escape or be washed into the stream or reservoir.

(c) No house slops, sink wastes, or other polluted water shall be discharged on the ground or into the ground within 50 feet of the high water mark of any watercourse or reservoir as above mentioned and no house slops, sink wastes, or other polluted water shall be thrown on the ground within 250 feet of such waters.

(d) No stable, pig pen, chicken house or other structure where the excrement of animals or fowls is allowed to accumulate, shall be located within 50 feet of the high water mark of any watercourse or reservoir as above mentioned, and no structure of this character shall be located within 250 feet of the high water mark of such waters unless provision is made for preventing manure or other polluting materials from flowing or being washed into such waters.

(e) The term high water mark as used in these regulations, applies to any depression into which water may flow at any time during the year.

Approved and adopted as a part of the Sanitary Code of Connecticut by the Public Health Council of the State Department of Health at its meeting on May 18, 1925, such regulation shall take effect on July 1, 1925.

Attest
STANLEY H. OSBORN,
Commissioner of Health

APPENDIX III

Injunction Against Injury to Water Supply

Sec. 2539 (amended by Sec. 930e). Whenever any land or building shall be so used, occupied or suffered to remain that it is a source of pollution to any river, brook or water which flows into any lake, pond or water from which ice is procured for domestic use or for use as an article of merchandise, and such ice shall be liable to pollution therefrom, or whenever any land or building shall be so used, occupied or suffered to remain that it is a source of pollution to the water stored in a reservoir used for supplying residents of a town, city or borough with water or ice, or to any source of supply to such reservoir, or when such water or ice shall be liable to pollution in consequence of the use of the same, the authorities of such town, city or borough, or the town health officer, or the person, firm or corporation having charge of such reservoir or the right to procure ice therefrom, may apply for relief to the superior court in the county where such reservoir or water is located, and said court may make any order in the premises, temporary or permanent, which in its judgment, may be necessary to preserve the purity of such water or ice. Such town, city, borough or company, by its officers or agents duly appointed, or the town health officer, may, at all reasonable times, enter upon and inspect any premises within the watershed tributary to such water supply or waters from which such ice is procured, and, if any nuisance likely to pollute such water or ice shall be found therein, such officers may abate such nuisance after reasonable notice to the owners or occupants of such premises and their refusal or neglect to abate the same, and such town, city, borough or company shall be liable for all unnecessary or unreasonable damage done to such premises.

APPENDIX IV

Section 544. Organization for municipal purposes. Upon the petition of twenty or more legal voters and taxpayers of any town, not residing within the territorial limits of any city or borough in such town, specifying the limits of a proposed district for any or all of the purposes set forth in section 545, and not including within such limits any part of any city or borough in such town, the selectmen of such town shall call a meeting of the legal voters residing within such specified limits to act upon such petition, which meeting shall be held at such place within such town and at such hour as the selectmen shall designate, within thirty days after such petition shall have been received by such selectmen. Such meeting shall be called by posting a written notice of the same, signed by the selectmen, upon some public signpost within such town and also in some prominent place within such proposed district, at least fourteen days before the time fixed for such meeting, and by advertising such notice in two successive issues of some newspaper published or circulated in such town. The provisions of this section shall not apply to the territory lying south of the tracks of the New York, New Haven and Hartford Railroad Company in the town of East Lyme.

Section 135g. Purposes of districts. At such meeting, the legal voters may establish a district for any or all of the following purposes: To extinguish fires, to sprinkle streets, to light streets, to establish building lines, to plant and care for shade and ornamental trees, to construct and maintain sidewalks, crosswalks, drains and sewers, to appoint and employ watchmen or police officers and to collect garbage, ashes and all other refuse matter in any portion of such district and provide for the disposal of such matter. They may name the district and choose necessary officers therefor to hold office until the first annual meeting thereof; and the district shall thereupon be a body corporate and politic and have the powers in relation to the objects for which it was established that are necessary for the accomplishment of such objects, including the power to lay and collect taxes. The clerk of such district shall cause its name and a description of its territorial limits and of any additions that may be made thereto to be recorded in the land records of the town in which such district is located. The provisions of this section shall apply to all districts organized under the provisions of this chapter.

APPENDIX V

Section 2657—Regulation of Sewerage for Dwellings

"Any town, city or borough may prohibit or regulate the construction of dwellings, apartments, boarding houses or hotels therein unless the sewerage facilities shall have been approved by the authorized officials of such town, city or borough. Any person, firm or corporation aggrieved by any order or regulation made under the provisions of this section may, within thirty days after the issuance of such order or regulation, appeal therefrom to the superior court for the county in which such municipality is located. Said court shall hear such appeal and shall proceed thereon in the same manner as upon complaints for equitable relief and may make such order, including taxation of costs, as it may find equitable."

Recommended Ordinance

No dwelling, apartment, boarding house or hotel shall hereafter be constructed in the town of .... unless the sewage disposal facilities are approved by the health officer or an inspector appointed by the health officer.

Appendix VI

Application for Permit for Construction of Sewage Disposal System

TO THE HEALTH OFFICER Application No.............
TOWN OF............................ Date ....

I hereby apply for permit to build a sewage disposal system for a
(Residence, boarding house, hotel, etc.)

Owned by .... of ....
And located at ....
To be built by .... of ....
in accordance with detailed information stated below.

Signed ....
(Applicant)

General Information

1. Estimated population of premises (present)..........(future)..........
2. Description of premises ....
   No. Fixtures
   (above basement): Water closets........Urinals........Lavatories........
   Bath Tubs......Showers......Kitchen Sinks......Laundry Tubs......
   List fixtures in basement ....
3. Water supply .... Kind of well ....
   (public, well or cistern spring)
   Location of well ....
   Method of obtaining or storing supply ....
   (pumps, tank, etc.)
4. Character of soil at proposed location of leaching system, including depths of various strata ....
   (sand, loam, clay, hardpan, etc.—use test pits)
5. Elevation of ground water ....
   (with reference to both present and future grades)
6. Description of proposed system (Furnish drawings of same, with plot plan showing system)
   **Septic Tank*
   Dimensions ....Capacity below flow line ....
   Facilities for cleaning ....Distance from water supply on same property ....,on adjoining property...........

---

* If privy or chemical toilet is proposed, submit information as to pit, fly proofing, chemical tanks, etc. on separate sheet.

Distance from property lines.............. Distance from dwellings on same property ...., on adjoining property ....

Automatic Dosing Apparatus, if any (describe) ....

....

....

***Soil Absorption System*

If cesspool, size is ....ft. diameter and ....ft. depth below inlet.

If tile field or leaching trenches, total length is ....ft.

Width of trenches ....ft., depth of broken stone or screened gravel.... ft. Stone or gravel will be covered by ....

(salt, hay, tar paper, etc.)

Distance between trenches ....ft. Distance from water supply on same property ...., on adjoining property................

Distance from property lines .... Distance from dwelling on same property ...., on adjoining property................

Secondary Treatment, if other than soil absorption.

Describe in detail, and locate on map. ....

....

System was designed by ....

Above information furnished by ....

APPENDIX VI A

(Suggested Form)

Permit To Construct Sewage Disposal System

TOWN OF..............................

Permission is hereby granted to ....
for the construction of a sewage disposal system on premises at ....
.... in accordance with description and plans as outlined in Application No. ....dated ....

Signed ....

(Health Officer or Inspector)

Dated ....

Note: This permit is issued with the understanding that future alterations or additions will be made, if necessary. This permit shall not be construed as permission to create or maintain any sewage nuisance.

Inspected during construction and approved for compliance with details as stated in application:

Signed ....

(Health Officer or Inspector)

Dated ....

** No discharge of sewage or sewage effluent into any watercourse should be permitted without approval of the state department of health and state water commission.

DISCUSSION

A MEMBER. I gather from Mr. Almquist's paper that in Connecticut they have uniform regulations in connection with the Public Health Council which apply to all surface supplies. Is that right?

FREDERICK O. A. ALMQUIST. That is right. We have sanitary-code regulations which take care of them.

THE MEMBER. That is in connection with the Public Health Council?

MR. ALMQUIST. That is right.

THE MEMBER. In the sanitary code is there authority for representatives of the water utilities to enter upon properties to make inspection, or is that provided by some basic state law?

MR. ALMQUIST. It is provided by a state law. The Commissioner of Health or his representative may enter properties for the purpose of inspection.

THE MEMBER. How about representatives of water utilities?

MR. ALMQUIST. That is covered under the statute that allows a water utility to obtain an injunction against anyone who might be violating the regulations or might have an unsatisfactory condition. Naturally, if utilities could get out an injunction against a person, they would have to have permission to enter the property, to be sure that they had the right to get an injunction. There is authority in the section under the injunction against injuries to water supplies that permits a representative of the water utility to enter that property for the purpose of inspection.

A MEMBER. It appears to me that what you have is not prevention, because a man starts pollution and it is a long time before you have him in court, and before you stop him. I think an act should be passed so that, if there is a person who is going to cause some sort of pollution, the Health Department should be able to stop it before it has occurred. It should be incorporated in the law that any building that is going to be erected in the watershed area should be subject to the approval of your department, so that it will be prevented if it is going to become a source of pollution.

MR. ALMQUIST. It is true that it is much better to prevent the possibility of pollution than it is to take care of it after it occurs. We try to prevent it through the local ordinances and we act in an advisory capacity to the local authorities. We recommend to the local utilities that they make frequent inspection of the watershed, to determine whether or not there are any new locations, and then through the enactment of ordinances, such as zoning and sewer ordinances and the requirement of building permits, which have to be approved before the building can be constructed, we try to control the situation. Did you mean visit the property before there is any construction or was your point that the State Health Department officials should make it rather than the local officials?

THE MEMBER. No. When the construction is going to be done, permission should be obtained and the matter should be referred not only to the building department but to your department, so that you will have notice of what is happening. If there is going to be some pollution which is detrimental to the watershed area, then you can stop it right at the time, before it has started.

MR. ALMQUIST. Our personnel is so limited that we can hope to do only about so much. In other words, we depend on the local people to let us know when there is any possibility of conduct that may be undesirable on the watershed in the future. We have to depend on the local communities and local officials pretty much.

A MEMBER. In looking at the other side of the picture, do you consider discharges from a filtration plant as polluting a stream and giving the downstream riparian owner an opportunity to take action against the water company or the utility?

MR. ALMQUIST. Fortunately that condition has not arisen as such in Connecticut. We are very lucky that we have no sewage-disposal systems from any public sewer.

THE MEMBER. I am thinking of discharges from water-filtration plants. The water supply is protected. Now, in the case of filtration plants, are the discharges from the filtration plant—filter washings, and so forth—considered as polluting the stream so that it would affect the downstream riparian owners? That is the basis of reciprocity. I wonder if that has come up.

MR. ALMQUIST. Our policy now, generally, in approving plants is not to approve plans in the future unless there is some means of lagooning or decanting the sludge and wash water from the filtration plants. I think there is no question but what anyone downstream can sue for damages.

A MEMBER. You spoke of possible contamination by our residential sources and others. How about contamination through industrial sources, industrial plants and large commercial institutions?

MR. ALMQUIST. Most of our water supplies are taken from upland sources, which are pretty clean. We have very few industrial plants on watersheds. We have some, of course. We try to obtain disposal of wastes in the ground, if possible. Wastes that are not toxic washings we can't hope to have any satisfactory disposition of, except into the streams, but with toilet wastes and any toxic substances we try to work out with the owner a satisfactory method of disposition. Incidentally, we have a State Water Commissioner who handles industrial wastes in our state, separate from the State Health Department.

LINN H. ENSLOW (New York, N. Y.). I would just like to display a little ignorance. As a former sanitary engineer of the State Board of Health of two different states, I had this code to go by, wherein you enter on the watershed but are not allowed to go farther back than 250 ft. I don't know that they gave the distance in this code I worked under, but if you go more than 250 ft back, seemingly you have no business trying to correct things. I should like to know where that 250 ft came from.

MR. ALMQUIST. I think it is just an arbitrary measure. I don't think it has any scientific value at all. As I mentioned, I think the danger of pollution from a source 400 ft from a stream, on a steep slope, is much worse than 200 ft on the level. However, beyond 250 ft we do not have any regulation and we try to play ball with the owner, and in most cases the owner of the property is agreeable. Probably the water department in that particular case might have assumed most of the cost of the correction, which is worth something as far as keeping the good will of the owner is concerned. But if it is over 250 ft I don't know of any way that it could be stopped, except to have the utility sue and let the court decide whether it was dangerous or not.

DONALD C. CALDERWOOD (Nashua, N. H.). On behalf of the

Association I want to thank Mr. Almquist for his very nice paper, and for the discussion and questions from the members. Of course you understand that these laws, which Mr. Almquist has quoted, are the Connecticut laws and the laws in your own state may be somewhat different. But once a state takes the lead, the laws are pretty much copied from state to state, to meet many of the conditions such as he has quoted here this morning.

SEISMIC RECONNAISSANCE FOR GROUND-WATER DEVELOPMENT

BY DANIEL LINEHAN, S.J.,* AND SCOTT KEITH**

[*Read September 16, 1948.*]

THE major ground-water supplies in the Northeastern United States are located in the glacial drift. This drift may be "in situ" from the time of its original deposition or it may be material that has been reworked by post-glacial erosion. It is true that some supply may come from drilled rock wells, but the amount derived from such a source is frequently undependable, as it is due to local jointing in the crystalline rocks rather than any aquifer value of the rocks themselves. Even those rocks that might be called aquifers, as the sandstones of the Triassic Basin, have low porosity and a supply for a municipality could not always be hoped for from these rocks. Artesian flow, taken in the strict sense, is at best a doubtful water supply in the Northeastern province. Accordingly, engineers in their search for municipal water supplies must first consider glacial deposits as the main source.

Science postulates three main advances and recessions of the ice sheet over the Northeastern United States during the Quaternary. Little evidence of the two earlier stages remains, since erosion by the final or Wisconsin stage removed most of the former drift and the remnants were covered by this last deposition. Where the older tills have been found, their aquifer value is low. Poor porosity, due to pressure, weathering and oxidation, together with their high clay content, renders these deposits poor water sources. Hence, it is the drift of the Wisconsin stage that is more generally sought.

Glacial drift is a general term covering many aspects of the material deposited by the glaciers. The moraines are deposits or walls of unsorted material, that may include the entire range from silt and clays to large boulders and rock fragments. Moraines may or may not be good aquifers in themselves, but when they have been reworked, the outwash gravels from them have proven excellent sources of ground water. Varved clays, the deposits on the beds of glacial lakes, are poor sources of supply. A kame terrace is drift deposited along the side of an existing glacier and an adjacent hill or valley wall, and is left as a terrace after the glacier has melted away. Usually small when appearing singly and able to cover but a small area, if large or making up a "kame field" (where several occur due to various successive stages of the melting which took place), these fields may become worth-while water deposits. Eskers have frequently proven good aquifers, but they are usually too narrow and drain too small an area to produce an abundant supply. Drumlins may have some deposits of porous gravels, but another section of the same deposit may prove a poor supply. Aeolian, or air-borne, deposits of glacial material, as sand dunes, etc., are poor sources for copious supply.

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**Project Engineer, Metcalf & Eddy, Engineers, 20 Providence St., Boston, Mass.

With these source properties in mind, the two main factors determining the desirable well location would be: 1) sufficient depth of gravels and 2) fairly porous gravels to allow speedy migration of the water. The depth might determine the type of system of supply. For example, in less than 30 ft. of gravels, a series of driven wells might be worked in parallel; if the depth were greater, then a gravel-packed well could be used economically. The authors have found that the quickest and most economical method of determining the two above properties is the seismic method.

The Seismic Method

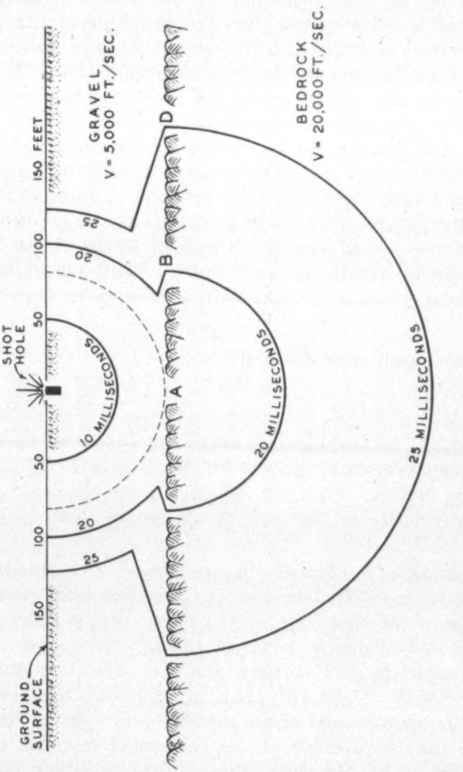
For a more complete understanding of the seismic method, the reader is referred to any of the books listed at the end of this paper. However, a brief explanation is included here, to assist one in understanding the present application.

There are two methods of seismic surveying or seismic prospecting of subsurface conditions. One method is known as the seismic reflection method and consists simply in timing the passage of a sound wave from the surface of the ground to a reflecting medium and its return to the surface. This method is chiefly used in the petroleum industry, where depths from 1,000 ft. to 30,000 ft. below surface are usually studied. It is quite impossible to employ reflections where the reflecting surface is shallow. Hence, we employ another, known as the seismic refraction method, where depths less than 200 ft. are being studied.

THE SEISMIC REFRACTION METHOD

Fig. 1 represents approximately 80 ft. of gravels, in which a sound wave will travel approximately 5,000 ft. per sec. Below these gravels is bed rock, in which the velocity of the same wave is 20,000 ft. per sec. Accordingly, a wave front leaving the shot point or sound source will be an approximate sphere of 50-ft. radius 10 milliseconds later. In Fig. 1 this is represented by the circle marked 10. At 16 milliseconds after the shot the wave reaches the bed rock at the point marked "A". From this point a new wave begins in the bed rock, but with increased speed, 4 times faster than in the gravels, and 4 milliseconds later it has reached the position marked by the circle 20 milliseconds. In the diagram the continuous positions of the wave front are shown, designated by the time after the shot took place. The diagram also shows how the wave front in the rock has outrun the same wave in the gravel medium. This is demonstrated near the point "B". As the wave moves along the gravel-rock interface or boundary, a new series of wavelets is generated, following Huygens' principle, and this wave again passes back through the gravels to the surface. This wave front is in reality the envelope of many wavelets, generated by the passing of the faster wave in the rock, and is similar to the "bow" wave caused by a ship speeding though water. At 25 milliseconds after the shot, the new wave is seen approaching the surface of the ground. Some moments later it will reach the surface of the ground, before the direct wave through the gravels reaches that same point. This wave, that has been "refracted" or bent back into the upper layers, is the wave used in this method of seismic surveying and has given the method its name.

In Fig. 2 is pictured the continued advance of the refracted wave until 50 milliseconds after the shot. For simplicity's sake, we have not represented all of the arrival times of the various waves, but merely those fronts that arrived first at a given point


GROUND SURFACE
150
100
50
SHOT HOLE
50
100
150 FEET
GRAVEL
V = 5,000 FT./SEC.
BEDROCK
V = 20,000 FT./SEC.
10 MILLISECONDS
20 MILLISECONDS
25 MILLISECONDS
20
25
20
25
A
B
D

POSITION OF WAVE FRONTS IN A TWO-LAYER PROBLEM

FIGURE 1.

distant from the shot position. We can see that at a point 200 ft. from the shot, the direct wave and the refracted wave have arrived at the same instant. Beyond that distance, the refracted wave arrives first and is the only one shown in the diagram. By plotting the arrival time against the distance, we are able to determine the velocity of the sound wave in the different media. Short of 200 ft. the arrival times fall along a straight line, the reciprocal slope of which is the velocity of the wave in gravel—viz., 5,000 ft. per sec. Beyond this distance, the line has a greater slope and shows a velocity of 20,000 ft. per sec., the velocity of sound in some rocks.

The point where these two lines intersect is controlled by the thickness of the gravel cover. A greater thickness than that chosen for the illustration would result in the intersection of the lines at a greater distance from the shot point. Thus the intersection distance is the seismologist's factor in determining the depth to bed rock.

A common formula for determining depth is:

$$h = \frac{d}{2} \left(\frac{V_2 - V_1}{V_2 + V_1} \right)^{\frac{1}{2}}$$

where "h" is depth to rock, in feet; "d" is distance from shot point to intersection, in feet; "V_2", the velocity of the wave in the rock, and "V_1", the velocity of the wave in the gravel, both in feet per second.

In the example illustrated, the bed rock is horizontal with respect to the surface. If, however, the bed rock were sloping upwards away from the shot, the refracted wave would have successively less and less distance to travel through the gravel and the arrival time would be less between stations. This line would not be the true velocity of the rock but an "apparent high velocity." A shot from the opposite end of the profile would show an "apparent low velocity" and the average of the two would resemble the true velocity of the rock. However, these "apparent" low and high velocities of the rock lines give the seismologist an idea concerning the attitude of the rock surface.

We have chosen but a two-layer problem. A several-layered

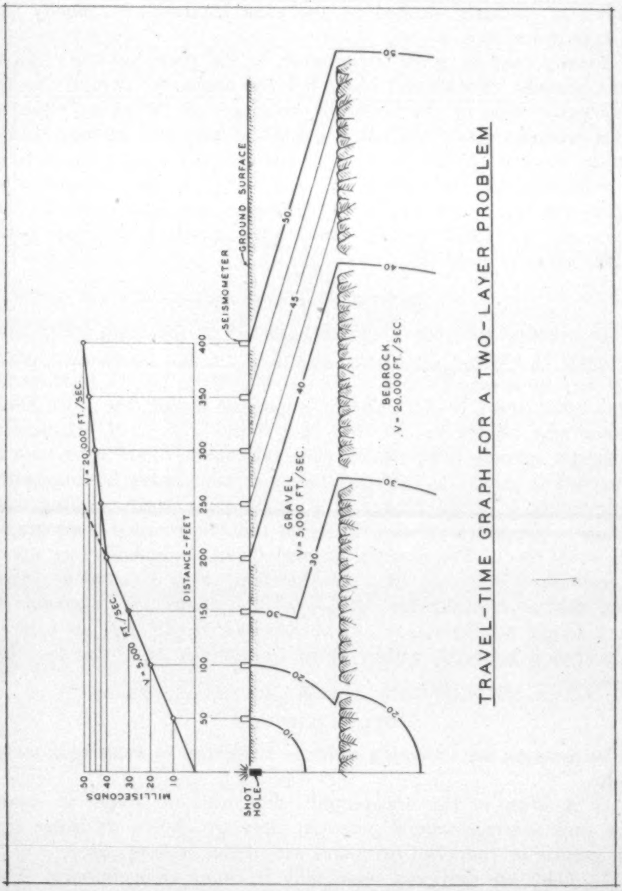

TRAVEL-TIME GRAPH FOR A TWO-LAYER PROBLEM
MILLISECONDS
DISTANCE - FEET
V = 5,000 FT./SEC.
V = 20,000 FT./SEC.
SEISMOMETER
GROUND SURFACE
SHOT HOLE
GRAVEL
V = 5,000 FT./SEC.
BEDROCK
V = 20,000 FT./SEC

FIGURE 2.

problem is similarly studied by the same method. A velocity line will appear for each layer.

Finally, and of great importance, is the fact that the velocity of the gravels, or whatever the top layer might be, suggests to the seismologist some of the physical properties of the cover material. If the velocities vary from 1,500 to 3,000 ft. per sec., we may believe that the material is fine sand, dry, and perhaps a poor aquifer. If the velocities are between 3,000 and 6,000 ft. per second, they suggest wet sands and wet or dry gravels. Velocities beyond 6,000 ft. per sec. to 10,000 usually denote poor aquifers, as "hard-pan", boulder clays or "old till."

EQUIPMENT EMPLOYED

In practice we employ 12 seismometers in the field, which may be spaced at various distances, depending on the problem at hand. They may be spaced from 5 ft. to 100 ft. apart. The 12 instruments in line constitute a profile and the longer the profile, the more linear distance may be covered per day, but detail such as is obtained in the shorter spacing is sacrificed. The seismometers are connected to the recording truck by cable. When the sound wave is propagated by exploding a buried charge of dynamite, the wave striking each instrument generates an electric signal that is recorded photographically in the truck. The record is developed and examined before any of the equipment is moved to a new location. Fig. 3 shows a typical record shot at Northbridge, Mass. In this manner, it is possible to give a rough determination of the bed-rock depth and an idea of the overlying material, within 10 to 15 minutes after the shot has been made.

FIELD TECHNIQUE

In practice the following order is suggested in locating a water supply:

1) A study of the topographic and geologic maps is made. From such a study several potential sites are chosen as being outwash gravels or reworked drift and within the drainage area.

2) They are surveyed seismically in order of preference. This preference may be determined by their proximity to the existing

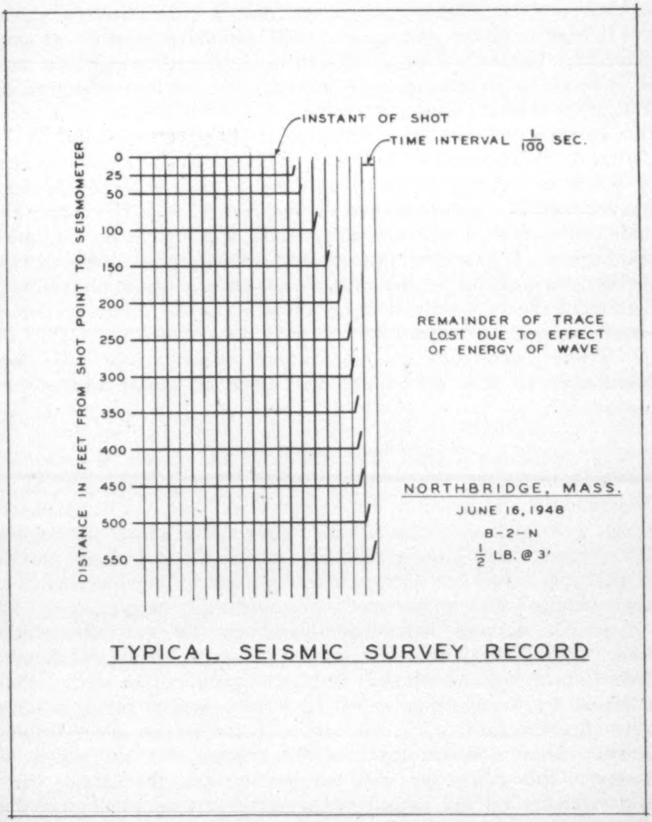

INSTANT OF SHOT
TIME INTERVAL 1/100 SEC.
DISTANCE IN FEET FROM SHOT POINT TO SEISMOMETER
0
25
50
100
150
200
250
300
350
400
450
500
550
REMAINDER OF TRACE LOST DUE TO EFFECT OF ENERGY OF WAVE
NORTHBRIDGE, MASS.
JUNE 16, 1948
B-2-N
1/2 LB. @ 3'
TYPICAL SEISMIC SURVEY RECORD

FIGURE 3.

water-distribution system, their desirability from the sanitary point of view, or such other factors as may bear on the particular problem.

Usually one or two profiles will determine whether an area should be further surveyed. If rock appears too shallow, the area is abandoned. If the rock is deep, but the surface velocities are indicative of poor porosity, the area is not abandoned but is demoted to a position of lower order, when test drilling is to be made.

It is difficult in New England to determine the actual presence of water by seismic methods, as there is an overlapping between the water-soaked sediments and the dry ones in velocity values. The main advantage of the seismic method appears to be the quick elimination of locations from a test-drilling schedule or placing the drilling machine in the proper location at a good site. It may even guide the driller who may have struck a boulder in his operations and thought it to be bed rock.

There follow some examples where seismic surveys were first operated, what they determined, and what the actual drilling tests proved.

EXAMPLES OF USE

Weston, Mass. In 1941, a seismic survey was operated in Weston, Mass., in a search for a suitable well site. At that time the driven wells at Kendal Green were supplying the entire consumption of the town, with little margin to spare during the driest portion of the year. Previous explorations by test drilling had failed to locate suitable sites to augment the ground-water supply.

Seismic surveys were made first near the two sites where driven wells already were in operation (Warren Avenue and Kendal Green), to determine whether bed rock might not be deeper than indicated by the existing wells. Lack of sufficient depth in these areas directed the surveys to various parts of the town, keeping always within economic reach of the existing distribution system However, this restriction was too limiting and the surveys were then extended without regard to the water system, resulting in the selection of sites near the Charles River.

In this region the seismic survey found bed-rock depths to more than 100 ft. below surface. These findings were consistent with indications of certain Metropolitan test borings. Further detailed surveys in this location found areas covered entirely by low-velocity sands and one area where higher-velocity gravels existed. This latter site was chosen for test drilling, despite the fact that the seismic data also demonstrated that some sand lenses occurred there. The first test well driven at this site proved satisfactory.

During the same year a permanent well was constructed by D. L. Maher Co. of Cambridge, Mass. The materials encountered were: loam from 0- to 2-ft depth; gravel, 2- to 10-ft depth; fine sand and clay, 10- to 30-ft depth; clay and stones, 30- to 32-ft depth; dirty gravel, 32- to 50-ft depth; and good water-washed gravel, 50- to 72-ft depth. The permanent well was constructed to a depth of 70 ft and included a 20-ft length of 24-in.-diameter shutter-type screen. The well delivered under test 800 gpm at a drawdown of 14 ft, equivalent to a specific capacity of 57 gpm per foot of drawdown.

Concord, Mass. Seismic surveys were made at two sites adjacent to the Sudbury River in Concord, Mass., in May, 1947, for the Water Department, of which John H. Robinson is Superintendent—at the so-called "Clam Shell Flats" on Route 2, just east of the river, and on property owned by the New England Deaconess Association on the Old Road to Nine Acre Corner, just south of the Emerson Hospital and just west of the river.

In this instance, a ground-water supply of about 1 mgd was being sought, in order that the town might have an auxiliary supply, thus permitting the shutdown and the cleaning and lining-in-place of the gravity supply main from Nagog Pond.

The results of the survey indicated that at the "Clam Shell Flats" about 20 ft of sand existed over gravel, before bed rock was reached. The general level of bed rock at this site was about 50 ft below ground surface. The velocity of the overlying material, 2,000 ft per sec., suggested that it might prove to be low-porosity sands. At the Deaconess property (Fig. 4) soil conditions were different; the sand layer was quite shallow and velocities, which varied from 4,200 to 5,000 ft per sec., suggested the presence of gravel. Depths to bed rock were slightly greater here than at the first site.

After the seismic survey, a contract for test drilling was awarded to R. E. Chapman Co. of Oakdale, Mass. During October, 1947, an 8-in. test well was placed by means of a cable-tool rig, immediately adjacent to the easterly end of the east-west profile (point G), where the greatest depth to rock was indicated by the seismic survey. Rock was encountered at a depth of 77 ft (El. 44.8 U.S.G.S. datum), as compared with a depth of 72 ft by the seismic survey. The materials encountered were sand and gravel.

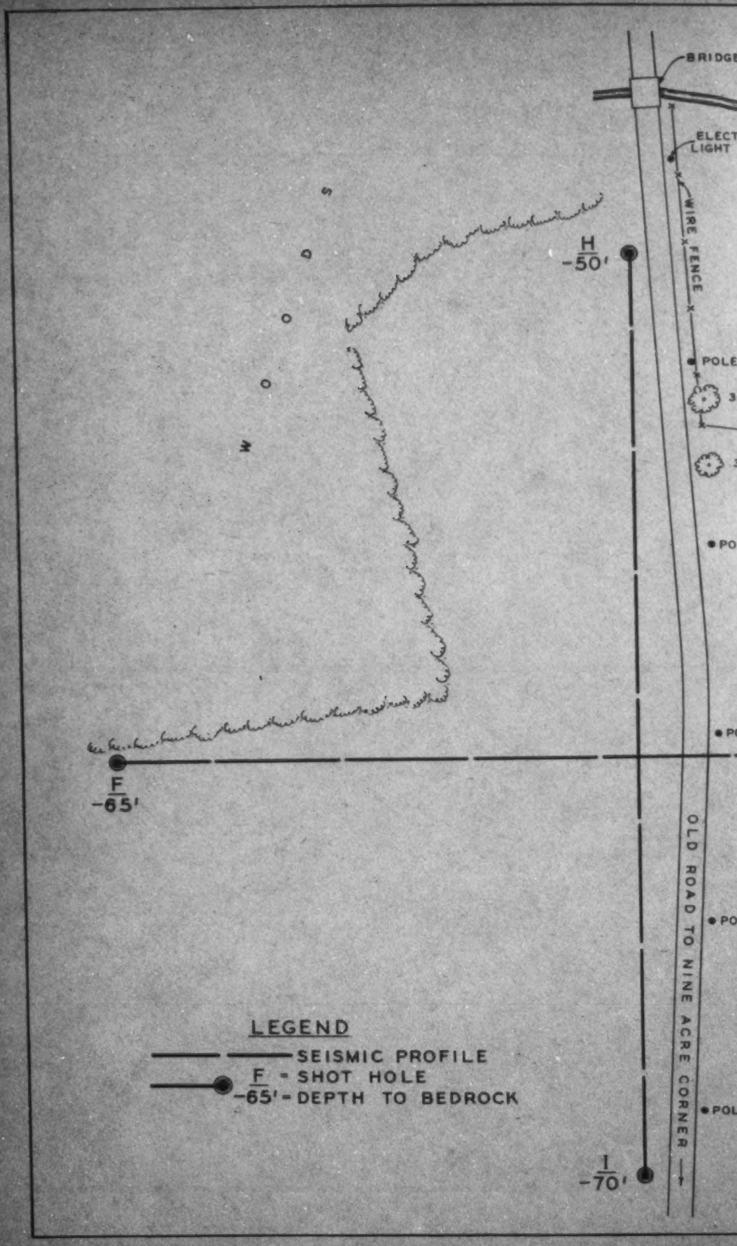
For test purposes, two 10-ft lengths of 8-in. Johnson screen were placed within the 8-in. casing and the casing was pulled back 20 ft. A pumping test was carried on for a period of 5 days and samples of water were taken periodically for analysis. The drawdown (as measured in an observation well, located about 11 ft distant from the 8-in. test well) stabilized at 8.5 ft below the initial static water level of El. 113.2 (U.S.G.S. datum) for a discharge rate of 350 gpm, equivalent to a specific capacity of about 40 gpm per foot of drawdown. The total cost of exploration, including seismic survey, test well and pump test, was $2,182.00.

A 24-in. gravel-packed well, 75 ft deep, with 30-ft length of 24-in.-diameter, stainless steel, shutter-type screen, has since been constructed within 6 ft of the original test well by D. L. Maher Co., Cambridge, Mass. A 10-day pumping test made during June-July, 1948, showed the following drawdowns within the 24-in. well:

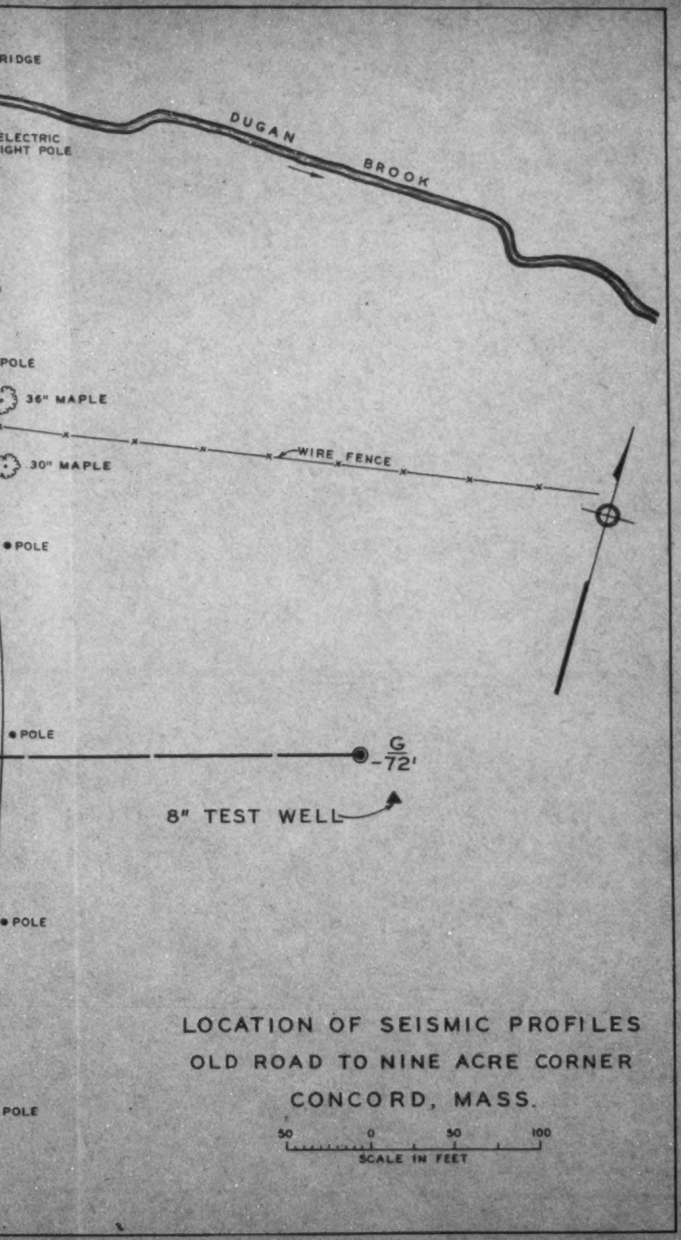
Rate of discharge, gpm	Drawdown, ft below static ground-water level
500	15.2
700	22.2
900	30.2

The well is being developed for a supply of 700 gpm and equipment is being purchased for permanent installation.

Naugatuck, Conn. Naugatuck, Conn., lies in the valley of the Naugatuck River, which cuts through the crystalline rocks of that region. The valley is deep and is fed by lateral streams on both the east and the west sides. In glacial times, lobes of the glacier deposited kame terraces in the lateral valleys. In post-glacial times these kames have been reworked and, in some places, gravels of good porosity may be found.


BRIDGE
ELECT
LIGHT
WIRE FENCE
POLE
3
3
PO
PO
PO
POL
WOODS
H
-50'
F
-65'
I
-70'
OLD ROAD TO NINE ACRE CORNER
LEGEND
SEISMIC PROFILE
F - SHOT HOLE
-65' - DEPTH TO BEDROCK

FIGURE


RIDGE
DUGAN BROOK
ELECTRIC
IGHT POLE
POLE
36" MAPLE
WIRE FENCE
30" MAPLE
POLE
POLE
G
-72'
8" TEST WELL
POLE
POLE
50
0
50
100
SCALE IN FEET

LOCATION OF SEISMIC PROFILES
OLD ROAD TO NINE ACRE CORNER
CONCORD, MASS.

URE 4

Seismic surveys were made at several sites during April, 1948, for the Naugatuck Water Co., of which William H. Moody is President and General Manager. The more favorable results were found along the New Haven Highway in the valley of Beacon Hill Brook, about 2 miles east of the center of town and in the general vicinity of an existing well of the company. Further exploration by test wells in this locality is in progress.

On the northerly side of the New Haven Highway, the depths to rock as determined by the survey varied from 50 to 60 ft. The surface gravels gave velocities between 5,000 and 6,000 ft per sec. Usually a gravel of slightly lower velocity might suggest better porosity, but it was thought that the high water table during the season of the survey might account for the velocities obtained. A test well drilled within 5 ft of the seismic profile indicated a depth of 23 ft of gravel overlying 33 ft of hardpan—a total depth to rock of 56 ft, as compared with a total depth by the seismic survey of 52 ft.

In the area lying south of the road, the elastic wave property through the gravels was also of high velocity. The materials encountered in driving one test well were 20 ft of hardpan, 2 ft of gravel, and then 26 ft of hardpan to rock—a total depth to rock of 48 ft. At a second test well, located about 100 ft north of the first well, the materials encountered were 14 ft of hardpan, 7 ft of coarse sand and gravel with considerable water, 24 ft of fine sand and clay, 1 ft of gravel and, finally, 10 ft of hardpan overlying ledge—a total depth to rock of 56 ft, as compared with a depth by seismic survey of 55 ft.

Comparison of the location of gravel and hardpan strata in the several test holes gave some evidence that the latter might pinch out toward the west and a further test well was located accordingly, but with disappointing results. It now appears that the relatively high seismic velocities were in fact due to density, rather than to saturation as had been hoped.

Southbridge, Mass. A seismic survey for the Southbridge Water Supply Co. was made during April, 1948, covering a 10-acre tract of land in the Westville section of Southbridge, Mass., adjacent to the Quinebaug River just north of South Street. Eight seismic profiles, each 330 ft long, covered the site. Fig. 5 shows the location of the seismic profiles.

The seismic survey indicated that the depth to bed rock varied from 10 to 70 ft. It also indicated that over the entire area there was a low-velocity layer, about 6 to 10 ft in depth below the surface, with a velocity of about 2,000 ft per sec. Under this top layer, the overburden had a velocity of 7,000 ft per sec. Usually materials with this velocity would be labeled as "hardpan" or old till and would not be considered a good aquifer. There was, however, the possibility that the high water content in these soils might have been caused by the spring thaws and the recent rains, resulting in an increase in the velocity. If this survey had been made in midsummer, there would be doubt as to the value of this area as a potential water producer. The bed-rock velocity was found to be about 20,000 ft per sec and the surface quite irregular. The region that appeared to be the best for test drilling was near shot holes "H" and "L". The bed rock appeared to dip to a center at these points.

An 8-in. test well was placed by R. E. Chapman Co., Oakdale, Mass., at Point H (the location of greatest depth to bed rock) by cable-tool. Rock was encountered at a depth of 67 ft, as compared with a depth of 70 ft by the seismic survey. The materials encountered in the drilling operations were reddish gravel and sand from 0- to 7-ft depth; fine gray sand with clay from 7 to 25 ft, and "rock flour" below 25-ft depth. The materials yielded no water.

To confirm these results before abandoning this site, a second 8-in. test well was placed about 50 ft east of Point D on seismic profile EF. Bed rock was encountered at a depth of 56 ft, as compared with a depth of about 60 ft, as interpolated from the seismic profile. This test well also produced no water.

Subsequent seismic surveys were made at six other sites in Southbridge and Sturbridge during July, 1948. Of these sites, three were found to have bed rock too close to the surface to warrant test drilling and two other sites were of doubtful value. The seismic survey at the remaining site, located adjacent to the Quinebaug River in Sturbridge, showed that bed rock averaged between 70 and 90 ft below the surface. The two cross profiles showed that there

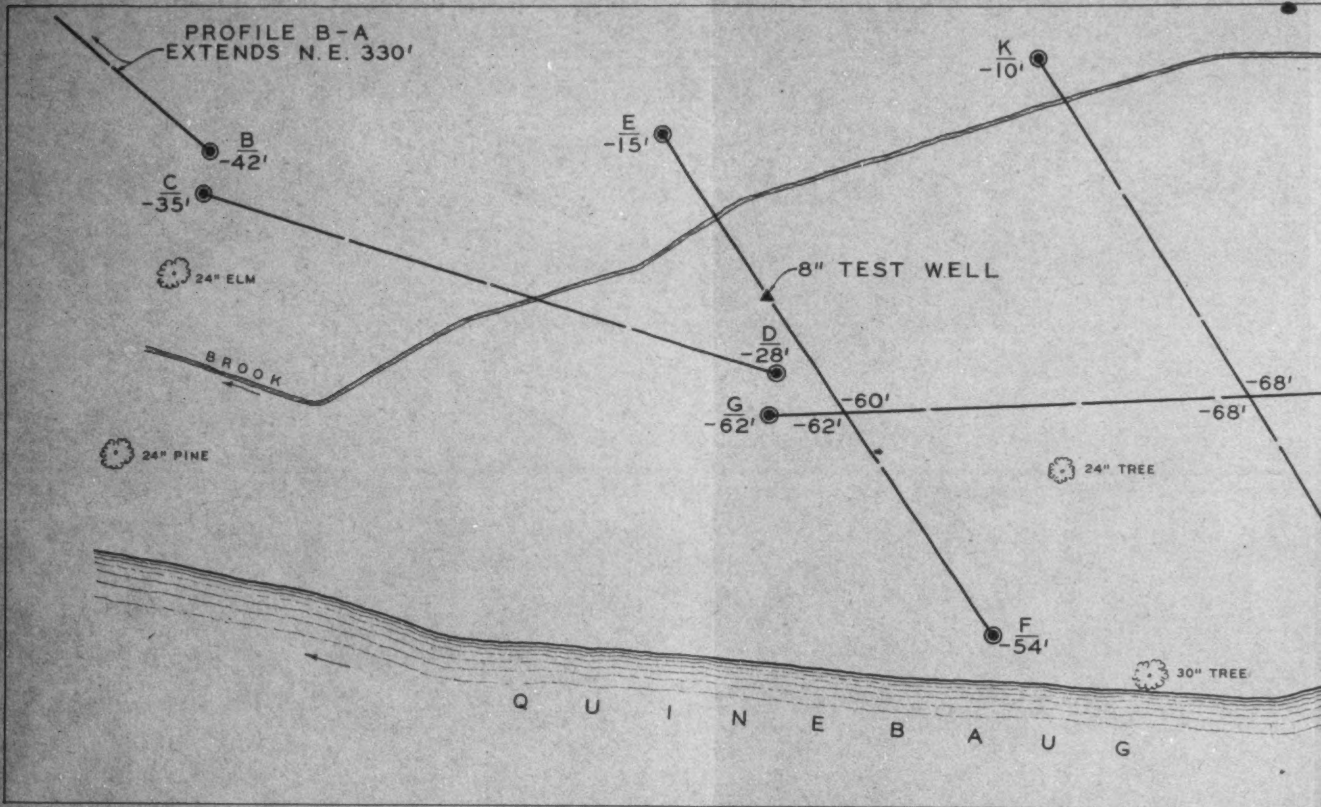
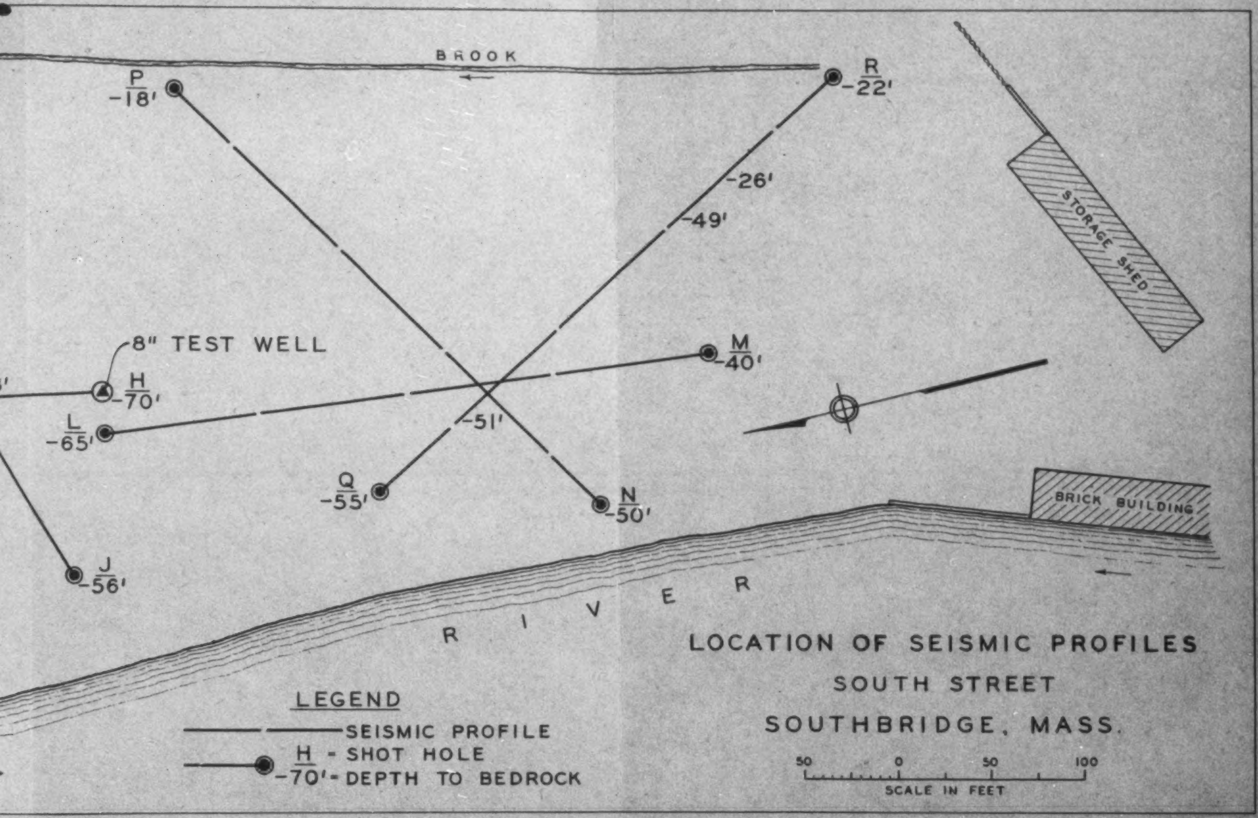

PROFILE B-A
EXTENDS N.E. 330'
K
-10'
E
-15'
B
-42'
C
-35'
24" ELM
8" TEST WELL
D
-28'
BROOK
G
-62'
-60'
-62'
-68'
-68'
24" PINE
24" TREE
F
-54'
30" TREE
QUINEBAUG

FIGURE 5


BROOK
P
-18'
R
-22'
-26'
-49'
STORAGE SHED
8" TEST WELL
H
-70'
M
-40'
L
-65'
-51'
Q
-55'
N
-50'
BRICK BUILDING
J
-56'
RIVER
LEGEND
SEISMIC PROFILE
H - SHOT HOLE
-70' - DEPTH TO BEDROCK
50
0
50
100
SCALE IN FEET

LOCATION OF SEISMIC PROFILES
SOUTH STREET
SOUTHBRIDGE, MASS.

RE 5

was no sudden rise of rock from the depths encountered. The gravel velocities were about 5,000 ft per sec. An 8-in. test well is to be drilled at this site.

Northbridge, Mass. Seismic surveys were made for the town of Northbridge and the Whitin Machine Works during June, 1948, at seven sites within the town limits. Three sites were within the Blackstone River valley and four sites were within the valley of the Mumford River. The purpose of the surveys was to locate areas with sufficient depth of gravel overlying bed rock to warrant test drilling for additional water supply.

Surface conditions along both rivers appeared the same, but apparently the preglacial and postglacial action of the Mumford River has not been as great as that of the Blackstone River. All sites within the Mumford River valley were eliminated by the surveys; bed rock was found to be at too shallow depth to justify further exploration.

The three sites within the Blackstone River valley all showed gravel velocities of approximately 5,000 ft per sec and depths to bed rock ranging to 100 ft below surface. One area was subsequently eliminated for sanitary reasons. The most desirable site, that at the gravel pit on Plummer Road, near the N.Y.N.H. & H. Railroad, indicated a low-velocity layer at the surface. This site was selected for further exploration and bids were received on August 12 for test drilling.

The remaining site on the Blackstone River, the so-called Cavanaugh site, was surveyed seismically in one afternoon with two profiles, each 550 ft in length, and one cross profile of the same length. Further exploration of this area is being postponed, due to its close proximity to the river and the relatively great distance of the site from the existing water-distribution system. A plan of the selected site, showing the location of the seismic profiles, is given in Fig. 6.

An 8-in. test well was driven by cable-tool by Layne-New York Company, Inc., at the intersection of the AC and EF seismic profiles. The materials encountered were as follows: 0- to 11-ft depth, sand and gravel; 11- to 57-ft depth, extremely fine sand; 57- to 67-ft depth, sandy clay; 67- to 71-ft depth, coarse sand and fine gravel;

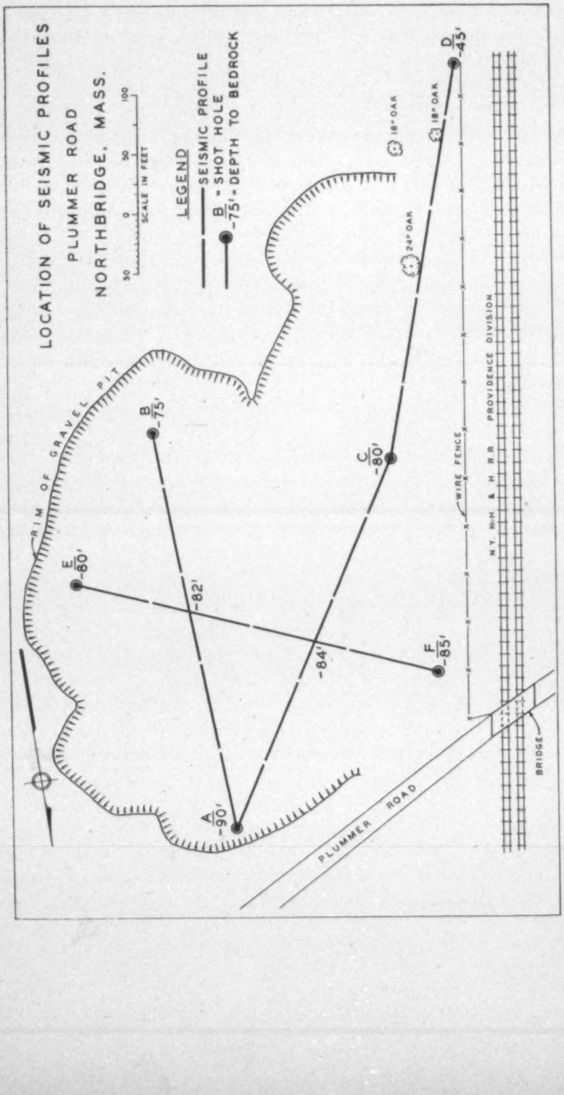

LOCATION OF SEISMIC PROFILES
PLUMMER ROAD
NORTHBRIDGE, MASS.
50 0 50 100
SCALE IN FEET
LEGEND
SEISMIC PROFILE
B - SHOT HOLE
-75' - DEPTH TO BEDROCK
RIM OF GRAVEL PIT
E -80'
B -75'
A -90'
C -80'
D -45'
F -85'
-82'
-84'
18" OAK
18" OAK
24" OAK
WIRE FENCE
N.Y. N.H. & H. R.R. PROVIDENCE DIVISION
PLUMMER ROAD
BRIDGE

FIGURE 6.

71- to 83.5-ft depth, water-bearing sand and gravel; bed rock at 83.5-ft depth, as compared with a depth to bed rock of 84 ft by the seismic survey. Additional test wells are now being drilled.

LIMITATIONS OF THE SEISMIC METHOD

The seismic method is not adaptable to small areas. An acre or two of land, for example, is too small to work on, since a seismic survey requires length of profile of at least three times the depth to rock. For the purpose of establishing the general rock slope, etc., it is desirable also to be able to survey several hundred linear feet of distance in several directions from the established site.

There are certain difficulties in obtaining a proper seismic survey; however, these difficulties generally are not such that they cannot be overcome. Thus, noise from traffic makes seismic work difficult in busy areas, but traffic may be stopped during the actual moment of testing. The use of explosives ordinarily is not hazardous, as the amount used per shot is small—only about ½ lb—and this is buried four or five feet in the earth.

Depth determinations may vary from the true value by several feet, but this lack of precision is more than compensated for by the rapidity with which an area can be covered. Even with very detailed surveying, such as with an instrument spaced every 30 ft, up to 3,000 linear feet of profile may be tested per day, the length depending upon the accessibility of the working area.

SUMMARY

The real advantage of using the seismic method in reconnaissance for ground-water development lies in its speed and economic saving. The eventual test-drilling and sample-taking are, of course, the final decisive tests and cannot be eliminated, but these should follow the seismic surveys. In a glaciated country, sites chosen from surface indications alone have too frequently proven unsuccessful, due to proximity of the bed rock or due to the slope of the bed rock. Elimination of such locations from the test-drilling schedule is easily and quickly made by the seismic survey.

ACKNOWLEDGMENTS

We acknowledge, with thanks, the courtesy of Messrs. John H. Robinson, Superintendent, Water and Sewer Department, Concord, Mass.; William H. Moody, President and General Manager, Naugatuck Water Co., Naugatuck, Conn.; W. H. Rogers, Vice-President, Southbridge Water Supply Co., Southbridge, Mass., and Delwyn K. Barnes, Agent, Water Department, Northbridge, Mass., for permitting use of data obtained by the seismic surveys and test drilling. A loan of seismic equipment by the Humble Oil and Refining Co., Houston, Tex., and the many courtesies of Messrs. D. P. Carlton and D. H. Gardner and Dr. M. M. Slotnick of that company are gratefully acknowledged.

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DISCUSSION

RICHARD HAZEN (New York, N. Y.). Cost figures were given for one of the jobs but they included a test drilling also. Can you tell us approximately what the seismic services on these works have cost?

DANIEL LINEHAN, S.J. I don't know what a professional outfit would charge, but far more than ourselves, because we have been in it more for the experience to date. It costs us in the neighborhood of $150 a day to run our equipment. We have been charging about $200 a day. This takes in the wear and tear on the seismic equipment. The truck itself is valued at about $30,000, with the equipment on it. That can be reduced, we think, with different types of equipment. Our equipment is built for oil prospecting. For water prospecting the equipment can be pulled down to something much smaller than will be carried in a big truck. We think that the price could be pulled down by a professional who really knew his business. We have been going about it in the most expensive way. It may turn out, however, that the professional will charge you three times as much; I don't know.

Mr. Hazen. On the average job, is that a week's work that has been discussed here this afternoon?

Father Linehan. No. For Concord it was one day. We turned up in the morning at one place and it was no good, and we went to the other in the afternoon. At Southbridge I think it was three days, and four days at Northbridge. The entire survey in a place like that might run to $1,000. That is not counting a couple of laborers that you will have to pick up some place or other, to dig the shot holes.

Arthur C. King (Taunton, Mass.). I think Father Linehan is quite modest about his qualifications, speaking of himself as an amateur rather than a professional.

Father Linehan. And in his prices?

Mr. King. Yes, and in his prices also.

Thomas H. Wiggin (New York, N. Y.). I don't think I can add anything to the discussion of costs by the seismic method, but I want to say that Father Linehan did a very interesting piece of work for us and, if we had been interested in water-bearing information, we would have got it from these surveys. We were interested particularly in the depth of bed rock on three dam sites and we found it very closely. Afterwards we drilled for the purpose of verifying the formation and to see what likelihood there was of percolation. I think two sites were about 3,000 ft and the other was about 1,500 ft. The correspondence between the seismic survey and the subsequent drilling was very close, the difference being generally less than 5 ft. I think the greatest difference was something like 10 to 12 ft, if I recall it correctly. It was a very interesting case and we enjoyed the relationship in doing that work. I certainly would never be without that service, if I could get it at any other time, because we did not have the faintest idea whether the rock there was 5,000 ft deep or 100 ft deep. No one had ever drilled it. We did not know how to place a contract for making wells or anything, but with this work—I don't think they took over three or four days for those three sites—we immediately had the whole picture and it was a correct picture.

Linn H. Enslow (New York, N. Y.). Is this method capable of detecting a fault in the rock structure?

Father Linehan. It depends. If you have had a fault in the rock, which has displaced in such a way that the rock is offset—has not eroded down to the original level—it will be detected very easily. A condition very similar to that was brought up in the Rochester survey. Right in the center of it there was a displacement of about 60 ft in the bed rock itself. If the rock has been displaced and a new type of rock brought up with different velocity, it can be detected also. If the rock is of the same velocity—displaces the same—I doubt if we can tell if there is a fault there at all. But usually on a dangerous faulting, where you have had a vertical slippage or displacement of 40 or 50 ft, I believe enough will be brought into place there so that we can determine that a new type of rock has been brought up or let down. By the reflection method in the oil fields that faulting is brought up quite easily and we can determine it there. In this refraction method it is a little more doubtful.

Paul F. Howard (Boston, Mass.). I think the members might be interested in this. At Lowell, Mass., the federal government, in connection with the Massachusetts Department of Public Works, had such studies made—I don't know who actually made these studies—locating the old Merrimack River bed, and the results were published. We are engaged now in locating an additional water supply for the city of Lowell. We have had a chance to test those studies out by installing numerous test wells. We have found the valleys as indicated very well. We have found the surveys of the ground or ledge following in the same direction and in about the same relative position as the studies indicated. It certainly is a great money saver to go into a community with this method and know at least where you have the depth of material, besides having some idea as to what you will find, though it is not conclusive. With the results in Lowell we have found good additional water supplies in the old, buried river valley that they located by this method.

N. J. Lusczynski (Jamaica, N. Y.). I should like to know whether they can identify the various forms of clay, sand and gravel down to bed rock with the same accuracy as they do the depths to bed rock.

FATHER LINEHAN. Given materials of sufficiently contrasting conditions, yes. We have run actual tests in Chicopee, Mass., for the highway department. Our survey there was so close that we just spaced the instruments five feet apart. Instead of using an explosion of dynamite, we just hit the ground with a shovel for our sound wave. We ran those tests on an average of 5 or 6 ft and, in subsequent borings which we made there with post-hole diggers, we checked in about 25 places within 0.5 ft. We are interested now in the groundwater level on the Cape, where we have been working with velocities of 3,000 ft per sec in the top sand and gravels into what we thought originally was a different type of gravel, but which has turned out to be a water table. We have been checking there within 3 or 4 ft of what the water table should be in that section. We feel we have very good accuracy between dry gravel and water-bearing gravel. If you get two sands or two gravels, they might be different in chemical composition and all that, but their other characteristics might be so close that sounds would travel the same in both of them, so that you could not tell the difference. We need some sort of discontinuity in our work.

CORROSION CONTROL BY THRESHOLD TREATMENT

BY JOHN H. WHITE*

[Read at Chemists' Round Table, December 16, 1948.]

APPROXIMATELY ten years ago the use of Calgon for corrosion control was introduced to the American public. The small amount of inhibiter required met the fancy of the water-works men and the use of Calgon for corrosion control has had quite general acceptance. Until last November the main obstacle to its use has been the lack of chemical. During the war large quantities were required by the armed forces and industry. Then came the post-war chemical shortage, which we are just now getting out of, having increased our manufacturing facilities.

Calgon is a glassy phosphate made of food-grade raw materials and is also referred to as metaphosphate or sodium hexametaphosphate. The raw materials, usually phosphoric acid and soda ash, are fused at high temperatures and then quickly cooled to normal temperature. To obtain a product which is highly soluble and of the desired property, both temperature ranges must be closely controlled.

There is quite a difference between the true chemical and the physical reactions of Calgon, which at first may seem to be inconsistent. A strong solution of Calgon is corrosive to most metals and it can even be considered a solvent. This is particularly true of iron and steel, and when the solution tank shows slight corrosion, we are asked how this can happen, when such a small concentration is being used to protect the system. However, the dilute solution loses this chemical solvency, which will be gone into later in more detail, and assumes surface active properties, which result in the laying-down of the protective film. It is these physical or surface active properties of Calgon in which we are primarily interested as water-works men.

Calgon is being used to prevent the laying-down of calcium scale in hard-water districts, but New England waters are relatively soft and, therefore, little use of this property is anticipated.

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*Chemical Engineer, Calgon, Inc., 49 Federal St., Boston, Mass.

Another use is for iron control in well-water supplies containing ferrous iron, which later precipitates on standing or in the presence of air. A number of systems in New England are using Calgon for this purpose and are obtaining clear, colorless water.

The main use, however, will be in corrosion control. Here we are using a principle almost as old as the use of metallic pipe itself. Most corrosion control depends upon the formation of a protective scale or film, or upon making a protective coating, such as the metallic oxide, more stable or adherent. These steps require the altering of the composition of the water itself and, particularly in the case of the protective scale, close chemical control is required, to prevent too rapid a build-up in the first part of the system and yet get some protection at the end. From a practical standpoint, such control becomes impossible and a compromise is settled upon, which does not give the desired protection but which likewise does not result in plugging up the system too rapidly. Some protective coatings can be applied mechanically with the systems out of service or before the pipe is installed and, as these coatings are uniform in thickness and usually impervious to the water, protection is achieved for the life of the lining. With Calgon a protective film is formed in the pipe. This film is one or two molecules thick and never grows any thicker. Therefore, it forms uniformly throughout the system and, being impermeable, gives very good protection not only in the main but in the consumers' piping as well. The control is quite simple and in most cases, once the feed is established, an occasional check of the residual Calgon at the ends of the system is satisfactory. The small quantity of Calgon required does not alter the taste, odor, color, hardness or pH value of the water. Likewise the cost over a long period of time seems comparable to the cost of coating mechanically installed in a system.

One factor involved in applying Calgon to a distribution system is the flow or rate at which the Calgon is supplied to the metal surfaces. The lower the flow through a given distribution system, the higher the Calgon concentration should be, to insure maintenance of the protective film. This is a very definite relationship and it has been shown that, if 10 lb. of Calgon per day will protect a system at a certain flow, the same quantity of chemical will protect the system, should the flow increase 50%. On the other hand, if the original flow should be decreased 50%, it is quite likely that the 10 lb. of chemical will be required per day, all other factors remaining the same.

A second factor—that of surface of the system—fits right in with the flow factor, as of course the Calgon requirements would be based on a ratio between the flow and the surface involved. The surface of the system, however, would include not only the metal but the presence of rust and other suspended or dispersible solids that are present in the system. With rust and tuberculation in a system, a higher feed of Calgon would be required at the beginning and perhaps flushing should be employed during the starting-up period, to remove such of this material as is dispersed by the chemical.

A third factor involved in corrosion control would be the presence of various salts in the water. From a practical standpoint this factor is taken care of quite satisfactorily, but by understanding the principle involved a better understanding of the formation of the protective film will be obtained. This protective film, which is depended upon for corrosion control, will not be formed in a distilled-water system. However, upon the addition of calcium salt to the distilled water, the protective film will form and can be maintained. Other salts, such as those of iron, react similarly. As calcium salts are present in natural waters, this factor does not have to be considered, as, unless excessively high feeds are contemplated, sufficient of these salts will be present to satisfy the requirement. It is only necessary to have the calcium content of the water one-quarter that of the Calgon concentration, to get a good protective film formation. Thus, with a normal feed of 2 ppm of Calgon, the calcium (as Ca) content of the water would have to be at least 0.5 ppm. However, if you want to feed 200 ppm of Calgon to get rapid film formation, the calcium content should be 50 ppm. This would have some value in protecting small systems where little circulation is experienced or, as will be described later, for preforming the film when batch-type corrosion experiments are to be made.

Calgon controls corrosion throughout the pH range normally encountered in water. Excellent corrosion control can be obtained at pH values as low as 5.0. A reduction in the amount of corrosion encountered can be obtained at pH values below this, but the efficiency seems to decrease. At pH values under 7, the corrosion that does take place is general in nature and will be neither noticeable nor troublesome. At pH values much above 8.0, any corrosion may leave an adherent deposit and is likely to be more localized in nature. Less corrosion will be encountered, however, with Calgon than under similar conditions in the absence of Calgon.

The use of Calgon for prevention of iron precipitation in well waters is probably the most spectacular use as far as the consumer is concerned. There are numerous well-water supplies in New England containing small amounts of iron, which can make the water look bad. However, it would be uneconomical to construct an iron-removal plant, in view of the quantity of water distributed from such well. As a usual thing, the iron present in these well waters is in the ferrous state and precipitates on standing as hydrous ferric oxide. The same is also true where manganese is present. Unlike corrosion control, where the chemical did not have to be proportioned to the flow or the constituents of the water, in controlling iron and manganese there is a definite relationship between the amount of these salts and the Calgon required. For some industrial waters, equal parts of Calgon to the total iron and manganese content will prevent precipitation and allow some color to develop. For domestic water, however, at least twice the iron and manganese concentration is advisable and four times the concentration is quite desirable, when a minimum of color is desired in the hot-water system. Water treated with four parts of Calgon for every part of iron and manganese can be used for normal household purposes without showing the presence of iron. Likewise, various persons have reported an improvement in the taste, although the absence of color may influence them greatly in this observation. There is no limit except economy to the amount of iron which can be kept in solution by Calgon. Numerous industrial installations are using Calgon to hold up 4-5 ppm of iron and there are quite a few domestic water supplies where the iron content is 0.5 to 1 ppm. In using Calgon for the prevention of iron and manganese precipitation, it is only necessary to use the proper quantity and to feed it to the system before air or chlorine is introduced. This usually means feeding the chemical to the suction side of the well pump, if it is possible to do so. If wide variation in the flow is encountered, the Calgon should be fed to take care of the maximum flow or else a proportioning system used.

It is quite normal for someone to admit that Calgon did a wonderful job in eliminating the corrosion difficulties in a certain town down the river and, therefore, want to know how he can test Calgon in his own water supply without a great expenditure of time, effort and money. It is impossible to take two test tubes containing the water in question, drop a nail in each of them and a little Calgon in one, shake them up, let them stand overnight, and observe the difference in the morning. We believe that most of you understand the factors involved and why such a test would not be satisfactory. The best way to test the Calgon and sometimes the cheapest way would be to add the proper amount to the system for a period long enough to get acceptable analytical results. By following the iron or dissolved-oxygen content of the water at various ends of the system and comparing these results with the analyses of the water as it enters the system, an excellent indication can be obtained as to how corrosion is being controlled. For larger systems, where this would not be feasible, a small quantity of the water can be treated and observations made, either by using weighed sections of tubing or by measuring the iron or oxygen content before and after passing through this pilot-plant-type setup. As flow is an important factor, an adequate amount of water should be used and an attempt should be made to simulate the flow in the distribution system. A test like this, carried out over an extended period of time, will clearly indicate whether or not Calgon will give the desired results.

Where batch-type tests are desired, it should be assumed that the test is to determine whether or not the protective film can be laid down on the type of metal under consideration. As such tests are usually for a relatively short period by their very nature, we would suggest the pre-formation of the protective film on the test specimens, by agitating them in a solution containing several hundred ppm of Calgon in about one liter of solution.

It is essential that the calcium content of the solution be at least one-quarter of the Calgon content. Either air or mechanical agitation may be employed. The length of time required to get this film in equilibrium is not very great and approximately one hour should be sufficient immersion time. Thereafter the natural water should be used and any loss in weight of the specimen or any pickup of iron or other metallic salts by the water should be noted. The volume of water used for this test should be at least 20 liters and the Calgon concentration should be at least 5 ppm. Mechanical agitation should be employed, although equally satisfactory results have been obtained with air for agitation, but the bubbling of air through the water will, of course, tend to change its properties. If 5 ppm or even 10 ppm give the desired result, this does not mean that the concentration will have to be that high to achieve protection of the system. The Calgon feed should be such as to insure having 0.5 ppm of unreverted phosphate in the water at the ends of the system. In some cases where dead ends are not troublesome or where the water is not excessively corrosive and protection of the consumers' equipment is not to be considered, a slightly lower residual would be effective.

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PROCEEDINGS

NOVEMBER 1948 MEETING

HOTEL STATLER, BOSTON, MASS.
Thursday, November 18, 1948

President Arthur C. King in the Chair.

Secretary Knox announced the election of the following new members:

Members:

Theodore V. Berry, Treasurer, Greater Vancouver Water District, Vancouver, B. C.; Francis J. Lariviere, Senior Sanitary Engineer, State of New Hampshire, Manchester, N. H.; Frederick G. Penniman, Whitman, Mass. (former member reinstated); George J. Coogan, Assistant Sanitary Engineer, Massachusetts Department of Public Health, Boston, Mass.; Gerard J. Gaynor, Foreman, Water Department, Woburn, Mass.; Henry J. Hunt, Partner, Mead & Hunt, Consulting Engineers, Madison, Wis.; Charles H. Lawrence, Sanitary Engineer, State Department of Health, Hartford, Conn.; Russell F. Ruhp, Superintendent, Salisbury Water Supply Co., Salisbury, Mass.; Chester R. Spielvogel, Superintendent and Treasurer, Southbridge Water Supply Co., Southbridge, Mass.

Juniors:

Sumner J. Weinstein, Senior Engineering Aide, Metropolitan District Commission, Construction Division, Boston, Mass.; Richard S. Woodhull, Sanitary Engineer, State Department of Health, Hartford, Conn.

A paper on "Diesel Pumping Unit for Manchester Water Works" was read by Clarence L. Ahlgren, Assistant Engineer, Manchester Water Works, Manchester, N. H.

A paper on "One Hundred Years of Public Water Supply for Boston" was read by James J. Matera, Superintendent, Wachusett Section, Water Division, Massachusetts Metropolitan District Commission, Clinton, Mass.

DECEMBER 1948 MEETING

HOTEL STATLER, BOSTON, MASS.

Thursday, December 16, 1948

President Arthur C. King in the Chair.

A sound moving picture, "Industrial New England," was shown by courtesy of the Boston & Maine Railroad.

A paper on "Drought Runoff in New England" was read by Charles E. Knox, Hydraulic Engineer, United States Geological Survey, Boston, Mass.

A paper on "The Case for Water Witching" was read by Lincoln W. Ryder, Assistant Engineer, Metcalf & Eddy, Boston, Mass.

JANUARY 1949 MEETING

HOTEL STATLER, BOSTON, MASS.

Thursday, January 20, 1949

President Arthur C. King in the Chair.

PRESIDENT KING. The meeting will please come to order.

It is with deep regret that I have to announce the sad news of the death of two of our members during the past month or so. I suggest that we all rise for a moment in their memory. [*The members stand.*]

Louis B. Davis, Manager of the Merrimac Municipal Water Department, passed away on January 9, 1949, at the age of 61. He was Water Commissioner for many years prior to his becoming Manager, a position which he held for the past 16 years. His reputation was as an able and exemplary water-works man, one who was always willing to lend a hand, and he was very well liked. He was a member of the New England Water Works Association for 13 years and a faithful attendant at the meetings. Mr. Davis is survived by his widow, Mrs. Ida Davis, to whom our deepest sympathies have been extended.

Oren M. Moulton, of the Engineering Department of the town of Brookline, also passed away January 9, 1949, at the age of 68. Mr.

Moulton was an engineer with the Engineering Department for 32 years, having spent 13 years prior to that time as an engineer of several power developments. He was very well known and respected in the water-works and engineering fields. He was a member of this Association for 32 years. Mr. Moulton is survived by his widow, Mrs. Daisy Moulton, and one daughter, Miss Martha Moulton, to whom our deepest sympathies have been extended.

The secretary has an announcement to make.

SECRETARY KNOX. At the Executive Committee meeting the following were elected to membership in the Association:

Herman Burgi, Jr., Chief Engineer, Portland Water District, Portland, Me.; Harold Thomas Smith, of Quito, Ecuador, engaged in water-supply construction in that country; Lloyd W. Nelson, Acting Superintendent, Milford Water Co., Milford, Mass.

A talk on "Power in New England" was given by Byron O. McCoy, Hydraulic Engineer, Charles T. Main, Inc., Boston, Mass.

A paper on "Sanitary Engineering in the Occupied Zone of Germany" was read by Major A. F. Meyer, Jr., Air Material Command, Wright Patterson Field, Dayton, O.

A paper on "Inserting a 24-Inch Main-Line Valve Under Pressure," illustrated with films, was read by Gerald J. Manahan, A. P. Smith Manufacturing Co., East Orange, N. J.

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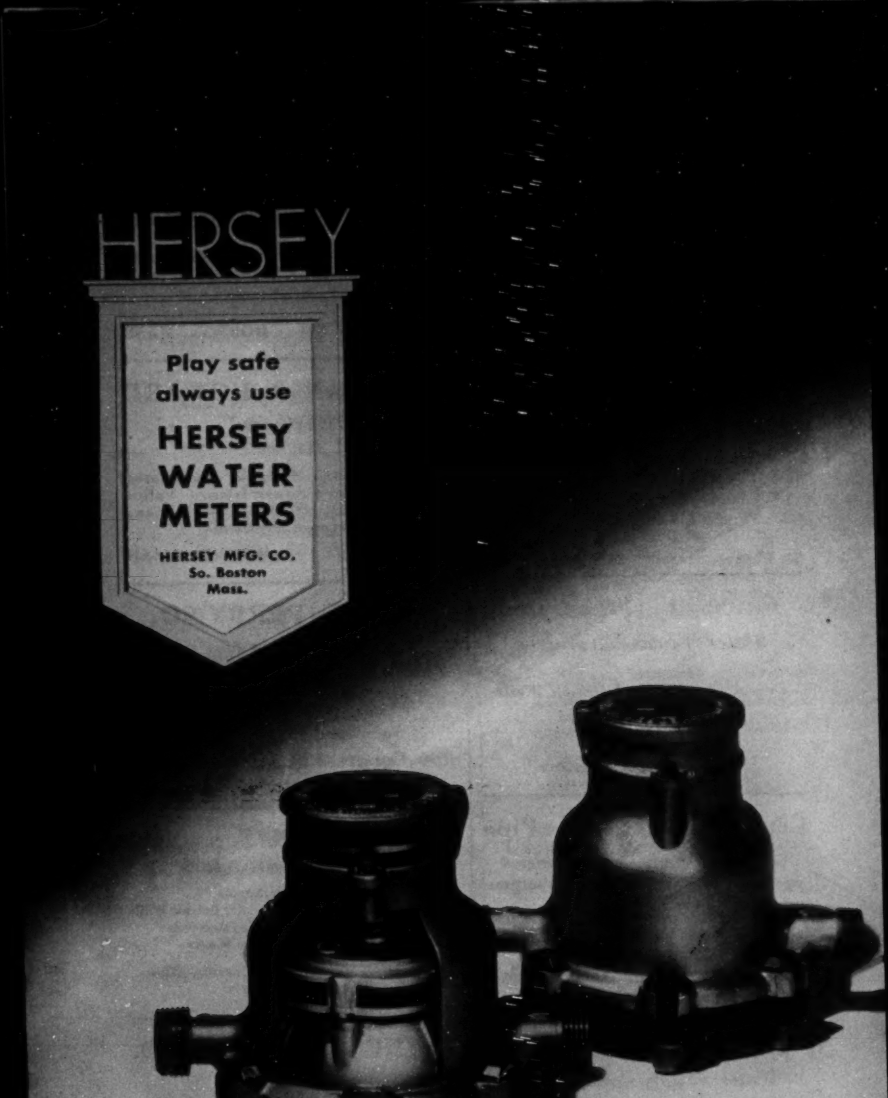
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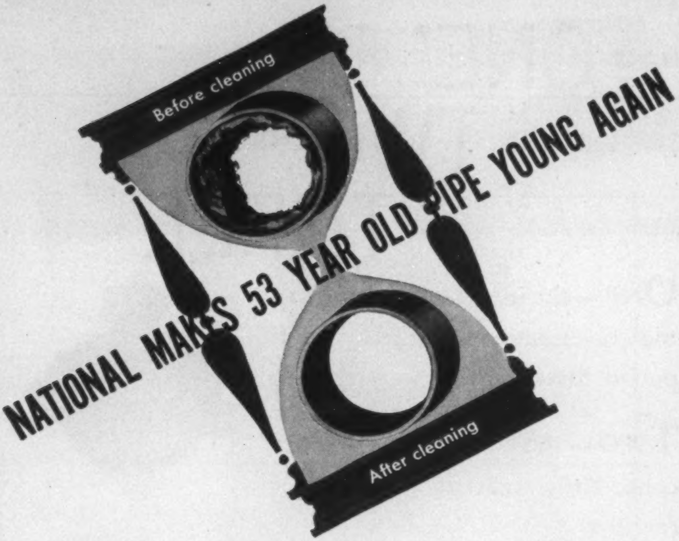
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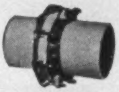

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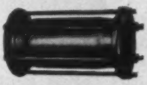

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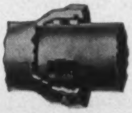

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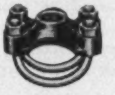

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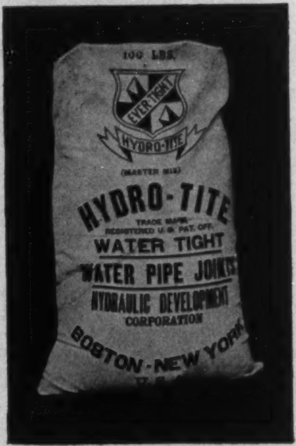
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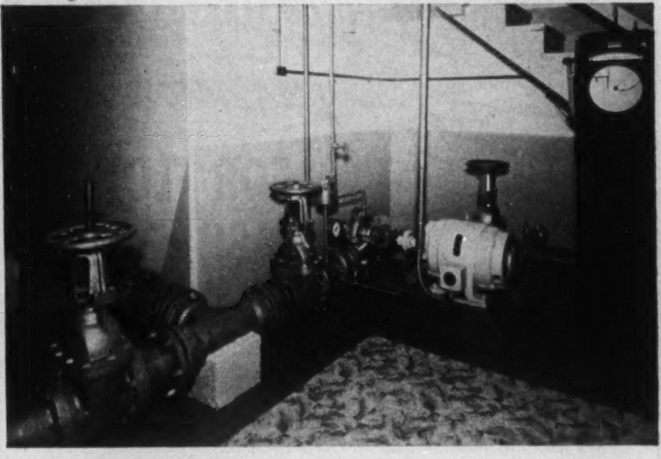

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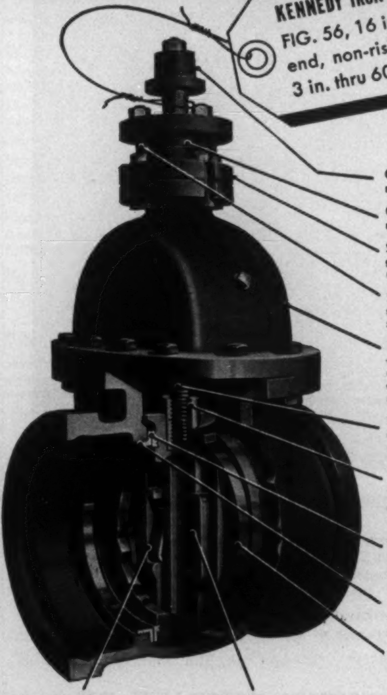

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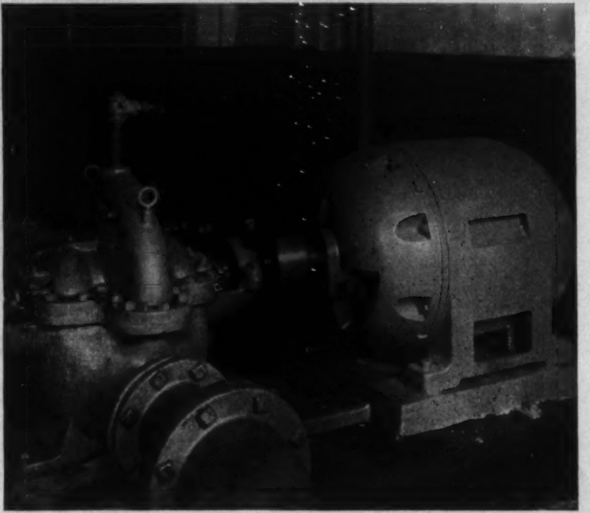

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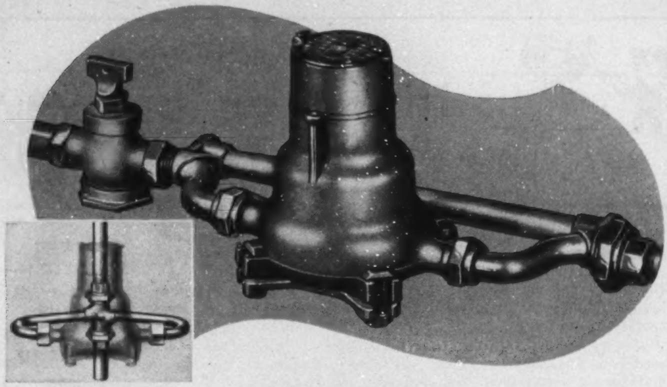

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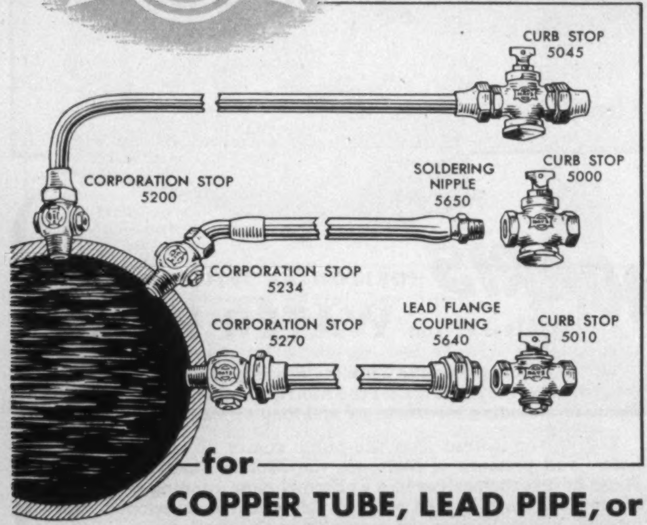
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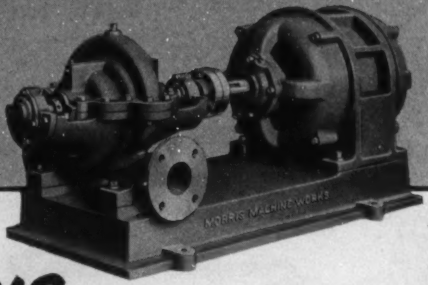

MORRIS HORIZONTAL SPLIT Double-Suction WATER PUMP

No other pump has the Floating Sealing Rings . . . yet this exclusive feature alone makes the Morris Double-Suction Water Pump outstanding for efficiency and long service.

During the instant that the pump comes up to speed, but before full pressure is built up, the Morris Floating Sealing Rings adjust themselves to a uniformly close running clearance around the impeller. As soon as full speed is developed, the internal hydraulic pressure acting upon the vertical face of the Floating Ring, presses it tightly against the precision machined surface of the casing ring where it is firmly held in place.

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MORRIS *Centrifugal Pumps*

EDDY

Valves and Hydrants

Distinctive Features of the EDDY Valves

ONLY three parts are moved by the Stem—the ball and the two gates. Each gate is hung from one of the trunnions on the ball. A convex surface at the base of each trunnion fits a concave surface on the back of the gate. This allows the gates to adjust themselves properly to their seats. . . . The gates, being free to revolve on the trunnions, do not always seat in the same position. Gates are center bearing and adjustable. They are forced to their seats with equal pressure at all points. There are two hooks on the ball on sizes 4-inch and larger, which loosely engage with the gates.

Distinctive Features of Our New Swivel Top Hydrants

THIS new hydrant has all the advantages of the popular EDDY fire hydrant, plus several additional features. . . . Nozzles are in a short flanged section of the standpipe, which may be unbolted and turned to different positions. . . . Should the standpipe be broken, only the casting below the swivel head need be replaced. . . . To raise the hydrant to conform to a new grading, simply insert a flanged extension piece below the swivelhead. No digging. To add a steamer nozzle at any time, it is only necessary to replace the swivel head with one having a steamer nozzle.

Besides valves and hydrants to meet the most exacting demands of waterworks service, the complete EDDY Line includes: valves for sewage disposal works; valves for steam, gas and oil; check valves, foot valves, plug valves, shear gates, indicator posts, etc. EDDY valves are made in three classes: Iron Body Bronze Mounted, All Bronze, and All Iron Valves.

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Eddy Valve Co.

WATERFORD NEW YORK

Two Birds with One Stone...

AT LITTLE ROCK

In the Little Rock Water System, organic growths reduced the capacity of a large reinforced concrete supply line by twenty percent.

According to L. A. Jackson, Manager, and W. A. Mayhan, Chemist, in a joint report appearing in Water & Sewage Works, the Break-Point Process when applied to this line greatly reduced organic growths and gave better results than any other method tried in a three-year test period.

Reduction of organic growths was not the only benefit however. According to the report "***Aside from destroying the organic growth in the transmission line, 'break-point' chlorination has proved of value to us in other ways. Since beginning this treatment, taste and odor flare ups have been practically nonexistent. We are assured a sterile water throughout the entire plant and lactose-fermenting organisms in the plant are a thing of the past.***"

This experience at Little Rock is representative of the multiple protection that you can obtain with the Break-Point Process. For complete details on other Break-Point benefits such as longer filter runs and iron and manganese removal, see your nearest W&T Representative.

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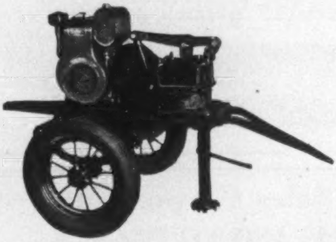
EDSON

PUMPS and ACCESSORIES



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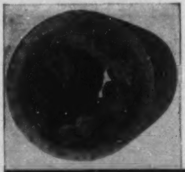

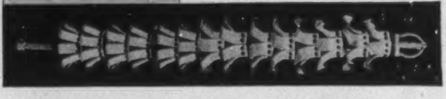

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1879—ROSS—1879

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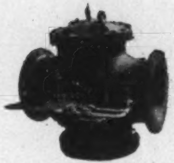

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ALTITUDE VALVE

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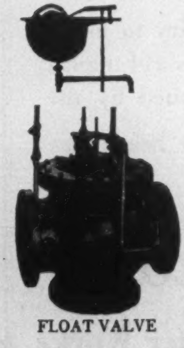
Maintains desired discharge pressure regardless of change in rate of flow

REDUCING VALVE

Regulates pressures in gravity and pump systems; between reservoirs and zones of different pressures, etc.



Maintains levels in tank, reservoir or basin

1. As direct acting

2. Pilot operated and with float traveling between two stops, for upper and lower limit of water elevation.

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Maintains safe operating pressures for conduits, distribution and pump discharge

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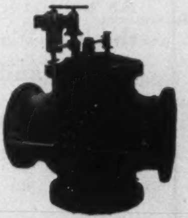

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REMOTE CONTROL VALVE

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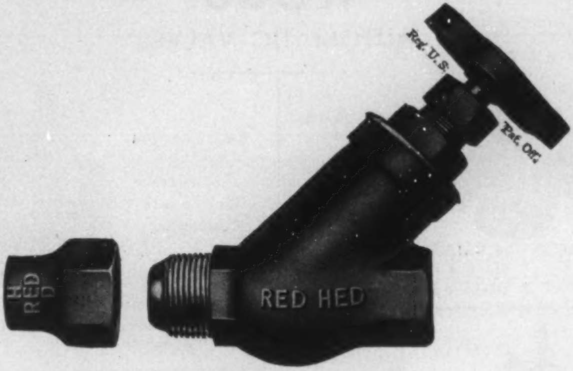

Fig. 460

RED HED BRONZE Y VALVE

WITH FULL UNOBSTRUCTED WATERWAY

Extra Heavy Pattern—Independent Drip
Bronze Wheel—Replaceable Seats

May be Packed Under Pressure

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The purchasers' interests have always been considered by us.

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RED HED Brass Goods for Water Works

368 Congress Street **Boston 10, Mass.**

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O3
In COMES Ozone

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Resists Corrosion
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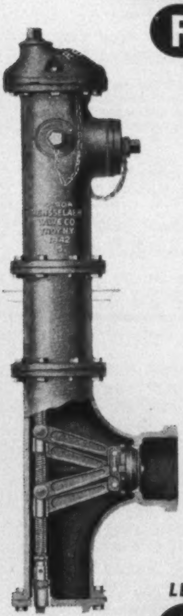
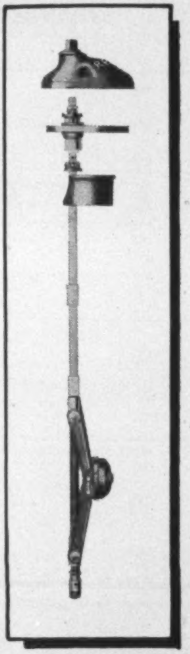


One man, with no special tools or hoist, without digging, by opening valve and removing head, can easily remove and replace all working parts of the RenSSelaer Corey Hydrant. That is only ONE feature which our 65 years of experience have incorporated in this famous Hydrant. NO FLOODING in case of barrel breakage. Main valve MECHANICALLY LOCKED shut by steel forgings bearing against case *(illustrated left).* No digging to renew broken barrel, thanks to flange at ground line. Hard rubber valve seats will not scar or leak. Drains fast, without clogging. No water hammer. Solid bronze protects long life of vital parts. There's no better investment than RenSSelaer Corey Hydrants . . . thousands in service prove it.



Working parts of Corey Hydrant

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96%

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CAST IRON PIPE SERVES FOR CENTURIES

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MAJOR credit for the virtual wiping-out of the typhoid fever scourge of 50 years ago is due to the growth and progress of public water works systems. In 1899, when our Company was established, there were about 3,000 public water works systems in America. Today, 12,000 water works furnish 85 million people with eight billion gallons of water per day, 90 per cent of which requires and receives treatment to make it safe.

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U.S.
CAST IRON
PIPE

1899-1949
U. S. Pipe & Foundry Co.
Makers for 50 years of cast iron pipe for water, gas and sewerage service.
General Offices: Burlington, N.J.

The Journal of the New England Water Works Association

is a quarterly publication, containing the papers read at the meetings, together with reports of the discussions. Many of the contributions are from writers of the highest standing in their profession. It affords a convenient medium for the interchange of information and experience between the members, who are so widely separated as to find frequent meetings an impossibility. Its success has more than met the expectation of its projectors; there is a large and increasing demand for its issues, and every addition to its subscription list is a material aid in extending its field of usefulness.

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BOSTON 8, MASSACHUSETTS

LEADITE

COSTS ARE REDUCED WHEN *LEADITE* IS USED

Of course, the greatest advantage in using LEADITE, is, that it makes a good, tight joint,—and thus reduces leakage to a minimum,—but LEADITE also offers the following advantages, which are worthy of serious consideration: Saves caulking expenses—Reduces cost of digging large bell-holes—Saves in cost of material—Reduces time required for pumping "wet trenches"—Saves time in preparation—Saves time in handling on the job—Saves in freight and hauling charges.

Another point, LEADITE saves "interest charges" by speeding up the completion of the water line.

The true value of LEADITE is best indicated by the fact that it has been used on THOUSANDS OF MILES of Water Mains,—all over this Country, as well as in many Overseas Countries.

The Pioneer self-caulking material for c. i. pipe,
Tested and used for over 40 years,
Saves at least 75%.

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CEMENT

No Caulking